Food and Agriculture Organization of the United Nations

From reference levels to results: REDD+ reporting by countries

2022 update

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From reference levels to results: REDD+ reporting by countries

2022 update

by

Marieke Sandker, Till Neeff , Anatoli Poultouchidou, Rocío Cóndor-Gólec, Francesca Felicani-Robles, Lucio Santos-Acuña and Amy Duchelle
Food and Agriculture Organization of the United Nations

and

Kimberly Todd
United Nations Development Programme

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Abbreviations and acronyms

A/R	afforestation/reforestation
AD	activity data
AGB	above-ground biomass
ART	Architecture for REDD+ Transactions
ART-TREES	Architecture for REDD+ Transactions - The REDD+ Environmental Excellence Standard
BGB	below-ground biomass
BioCF ISFL	BioCarbon Fund Initiative for Sustainable Forest Landscapes
BR	biennial report
BTR	biennial transparency report
BUR	biennial update report
CERF	Climate Emissions Reduction Facility
CF	carbon fund
COP	Conference of the Parties (to the UNFCCC)
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DW	dead wood
EF	emission factor
ER	emission reduction (in this publication this also includes removal increases; see Box 1)
ERPA	emission reduction payment agreement
ERPD	emission reductions programme document
ER-PIN	emission reductions programme idea note
ETF	enhanced transparency framework (under the Paris Agreement)
FCPF	Forest Carbon Partnership Facility
FCPF CF	FCPF's carbon fund
FCPF MF	FCPF's methodological framework
FMT	facility management team
FRA	global forest resources assessment
GCF	Green Climate Fund
GFOI	Global Forest Observations Initiative
GHG	greenhouse gas
GST	global stocktake
HFLD	high forest, low deforestation
ICA	international consultation and analysis
IPCC	Intergovernmental Panel on Climate Change
iTAP	independent technical advisory panel

ITMO	Internationally Transferred Mitigation Outcome
JCM	joint crediting mechanism
L	litter
LEAF	lowering emissions by accelerating forest finance
LOI	letter of intent
LULUCF	land use, land-use change and forestry
MPGs	modalities, procedures and guidelines
MRV	measurement, reporting and verification
NDA	nationally designated authority
NDC	nationally determined contribution
NFI	national forest inventory
NFMS	national forest monitoring system
NICFI	Norway's International Climate and Forest Initiative
PSP	permanent sample plot
RBP	results-based payment
REDD+	Reducing Emissions from Deforestation and Forest Degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
REM	REDD Early Movers
TA	technical assessment
TAP	technical advisory panel
TREES	The REDD+ Environmental Excellence Standard
UNFCCC	United Nations Framework Convention on Climate Change
VCS-JNR	verified carbon standard – jurisdictional and nested REDD+ framework
VCU	verified carbon unit
VVB	validation and verification body

Chemical formulae/units

CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
ha	hectare(s)
m	metre(s)
tCO_2eq/yr	tonne(s) of carbon dioxide equivalent per year
USD	United States dollar(s)

Executive summary

Forests play an important role in climate change mitigation, especially through reducing emissions from deforestation. **Article 5 of the Paris Agreement** calls for action on **Reducing Emissions from Deforestation and Forest Degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+)**.

In 2007, the United Nations Framework Convention on Climate Change (UNFCCC) recognized the significance of REDD+ in climate change mitigation through the Bali Action Plan the Conference of the Parties (COP 13) and in 2013, the Warsaw Framework (COP 19) finalized decisions related to measurement, reporting and verification (MRV) of REDD+ activities. In 2015, the Paris Agreement (COP 21) was adopted, providing a **new and important context for REDD+** requiring each Party to prepare, communicate and maintain successive **nationally determined contributions (NDCs)** – high-level political commitments made by countries to undertake transformative low-carbon and climate-resilient action and contribute to the global response to climate change (Article 4, paragraph 2). The Glasgow outcomes on **Article 6 provide a framework for international transferability of mitigation outcomes among public and private entities under the Paris Agreement**, which may apply to REDD+ results.

Developing countries achieving REDD+ results could be **awarded results-based payments (RBPs)**, which may come from a **variety of sources, including the Green Climate Fund (GCF)** – an operating entity of the financial mechanism under the UNFCCC. The GCF launched a pilot programme for RBPs in 2017, but its envelope was depleted in 2020 and a subsequent phase is still under discussion. Meanwhile, the **voluntary carbon market has seen considerable growth** in recent years, providing **new RBP opportunities for jurisdictional REDD+**. In 2021, two updated jurisdictional REDD+ accounting standards were launched: the **Architecture for REDD+ Transactions' – The REDD+ Environmental Excellence Standard (ART-TREES)** Version 2.0 and the **Verified Carbon Standard – Jurisdictional and Nested REDD+ (VCS-JNR)** Version 4.0. Towards the end of 2021, the first RBP under the **Forest Carbon Partnership Facility's Carbon Fund (FCPF CF)** was made**.** These standards or programmes include MRV requirements that build upon UNFCCC modalities and go beyond, aiming to ensure high-integrity emission reductions (ERs) (Decision 9/CP19 notes that additional verification may be needed for UNFCCC reported REDD+ ERs to move to markets).

This report provides an overview of UNFCCC modalities for REDD+ reporting and additional **technical MRV requirements** from different standards for accessing jurisdictional REDD+ RBPs, focusing on **REDD+ reference levels and results reported**, illustrating the **choices countries have made when constructing their reference levels**. Beyond the **GCF RBP pilot programme**, the jurisdictional REDD+ RBP opportunities discussed are the **FCPF CF**, **ART-TREES,** and **VCS-JNR**. By September 2022, only one country had submitted REDD+ results (in the monitoring report) to ART-TREES and only one jurisdictional REDD programme account hadbeen listed in the VCS registry.

As of September 2022, the following UNFCCC REDD+ reporting milestones had been achieved:

- Since 2014, **56 countries** had submitted **75 reference levels** to the UNFCCC.
- These reference level submissions collectively cover a **forest area** of approximately **1.35 billion hectares (ha)** (33 percent of global forest area); the countries that submitted a REDD+ reference level to the UNFCCC are responsible for approximately **75 percent of global deforestation**.
- Since 2014, **18 countries** had reported **REDD+ results** to the UNFCCC through **27 results submissions** (in the REDD+ technical annex of their biennial update reports [BURs]).
- The combined reported REDD+ results are in total **11.5 billion tonnes of carbon dioxide equivalent** (tCO_2eq) achieved between 2006 and 2020, which correspond to on average 765 million tCO_2eq/yr. The majority (82 percent) of ERs was reported by Brazil.

As of September 2022, the following milestones had been achieved on REDD+ RBPs:

- The **UNFCCC Info Hub** listed **386 million tCO_2eq** of REDD+ results to have been **awarded RBPs** for results achieved between 2006 and 2016 for seven countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador and Indonesia).
- **GCF RBP pilot programme:** Since 2019, REDD+ RBP funding proposals of **eight countries** (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Indonesia and Paraguay) have been approved by the GCF, offering a total of **133 million tCO_2eq** to the programme. **RBPs of USD 497 million** (**97 million tCO_2eq**) have been disbursed, most of which are included in the Info Hub total.
- **FCPF CF:** Since 2020, **seven countries** (Chile, Costa Rica, Fiji, Ghana, Mozambique, Indonesia and Viet Nam) had reported REDD+ results through eight monitoring report submissions to the FCPF CF. Of the eight submissions, six are available online with combined **ERs of 104 million tCO_2eq**. Two countries (Costa Rica and Mozambique) received

RBPs of a total of USD 22.8 million (for **4.6 million tCO_2eq**), and one country (Ghana) has recently successfully concluded the validation and verification; RBPs are expected shortly.

- **ART-TREES:** Since 2022, **one country** (Guyana) submitted REDD+ results to ART-TREES in a monitoring report with REDD+ results of **41.6 million tCO_2eq**; verification and validation is ongoing.

This publication discusses discrepancies between REDD+ results reported to the UNFCCC and REDD+ accounting towards receiving RBPs, especially differences in volume: **11.5 billion tCO_2eq ERs were reported to the UNFCCC, while 146 million tCO_2eq ERs were reported to the FCPF CF and ART-TREES combined**. Though ER reporting to the voluntary carbon market has only recently started and may still increase, its volume is expected to be limited, due to certain factors, such as the **exclusion of early achieved ERs**, the **shortening of the reference period,** and the **assessment of ERs with sample-based approaches**.

The world's collective progress towards achieving the Paris Agreement and its long-term goals is assessed through the **global stocktake (GST)**. The last part of this publication shows how some countries are using REDD+ reporting to improve their NDCs, BURs and biennial transparency reports (BTRs). The **mitigation potential of REDD+** is discussed in the context of the GST exercise.

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1. Introduction

This report complements and updates *From reference levels to results reporting: REDD+ under the UNFCCC* (FAO, 2017, 2018a, 2019, 2020). The previous reports may still be of relevance since each of them has in-depth sections on the following specific topics:

The 2020 update includes in-depth information on:
- the IPCC 2019 refinement and how it influences REDD+ reporting;
- the use of multiple national forest inventory (NFI) cycles to assess the carbon flux in forest land remaining as forest land; and
- the share of historical emissions coming from forest degradation and deforestation.

The 2019 update includes in-depth information on:
- the impact of delayed emissions and removals on REDD+ reporting;
- uncertainties around ERs and how improvement in data can, in some cases, lead to larger confidence intervals;
- lessons learned from stratified area estimation; and
- the enhanced transparency framework (under the Paris Agreement) (ETF).

The 2018 update includes in-depth information on:
- the difference between pixel counts, stratified estimates and systematic samples;
- differences between greenhouse gas (GHG) inventories and REDD+ reporting; and
- sources of error in estimates of emission factors (EF) and activity data (AD).

The report furthermore builds on the following previous UN-REDD Programme/FAO publications: *Technical considerations for forest reference emission level and/or forest reference level construction for REDD+ under the UNFCCC* (FAO, 2015a); *Strengthening national forest monitoring systems for REDD+* (FAO, 2018b); *National forest monitoring systems: monitoring and measurement, reporting and verification (M&MRV) in the context of REDD+ activities* (FAO, 2013); and *Emerging approaches to forest reference emission levels and forest reference levels for REDD+* (FAO, 2015b).

1.1. OBJECTIVES AND TARGET AUDIENCE

REDD+ reporting is immensely complicated. The context is becoming increasingly complex with several reporting lines and contexts that countries now turn to as voluntary carbon markets offer new opportunities for REDD+ RBPs. Extracting key information from country reports is difficult due to their length and level of technical detail. While hard to come by, aggregate information could help countries to **improve their understanding** and be able to **navigate this complex environment**.

The aim of this paper is to inform countries and other stakeholders with an interest in achieving and financing ERs from forests about recent developments in the MRV of REDD+ activities under different national and subnational REDD+ reporting processes or schemes.

1.2. REDD+ REPORTING UNDER THE UNFCCC

Recognizing the important role of forests in climate change mitigation, the Parties to the UNFCCC adopted the Bali Action Plan in 2007 (COP 13), inserting REDD+ firmly into the negotiations. Subsequent Conferences of Parties (COPs) provided important additional guidance and modalities, and the most critical decisions related to MRV of REDD+ activities were finalized in the Warsaw Framework (COP 19) in 2013. In 2014, the first reference level (see Box 1) was submitted to the UNFCCC.

The **long history of negotiations and REDD+ reporting under the UNFCCC** has created building blocks that have allowed countries to make substantial progress in developing and institutionalizing their national forest monitoring systems (NFMS) to provide MRV for REDD+ reporting (FAO, 2021a).

Box 1
Terminology for REDD+ reference levels, emission reductions, results-based payments and reporting versus accounting

Reference level: Different terminology is used for benchmarks to assess REDD+ performance expressed in tCO_2eq. The UNFCCC uses "forest reference emission levels and/or forest reference levels", but does not define the difference between the two. In this publication, it is assumed that forest reference emission level includes only net emitting activities, while a forest reference level also or only includes removals from "plus" activities. ART-TREES refers to "crediting levels"; the FCPF CF uses the term "reference levels"; and VCS-JNR uses "forest reference emission levels" for jurisdictional-level benchmarks and "baselines" for project-level benchmarks. The term "reference level" is used throughout this publication to refer to any of the above definitions, except when the term appears in a quote from another text.

Emission reductions: In this publication, REDD+ results are referred to as emission reductions (ERs), though they may also include removal increases from "plus" activities.
Results-based payments: In this publication, results-based payments (RBPs) refer to payments for REDD+ ERs that are fully measured, reported and verified. A distinction can be made between non-market RBPs and market-based RBPs: we use **non-market RBPs** to refer to finance, where the payment volume is determined by the amount of ERs and there is no transfer of ownership of ERs; we use **market-based RBPs** (also referred to as carbon finance for ERs) for revenue generated through the sale of ERs, in the form of **carbon credits** (meaning the title is transferred to the buyer), which could be used as offsets (i.e. to compensate other emissions). In this early phase, market-based RBPs are being piloted. For example, the FCPF CF is a fund with a predetermined volume to be purchased at a predetermined price piloting RBPs (FCPF calls them ER payments), where only part of the ERs sold to the FCPF CF will see a title transfer. In this publication, these will be referred to as market-based RBPs, even if they are not traded in markets. A further distinction can be made between **carbon markets for compliance purposes** (e.g. internationally transferred mitigation outcomes [ITMOs]) and **voluntary carbon markets** (e.g. for corporate voluntary action).
Reporting and **accounting**: The UNFCCC makes a distinction between reporting and accounting. Reporting relates to estimates of national GHG emissions and removals provided through for example national communications (NCs) and national GHG inventories. By contrast, accounting refers to quantification to assess whether a country achieved a quantitative commitment. For example, the Paris Agreement, Article 4, states that "Parties shall account for their nationally determined contributions (NDC)". The UNFCCC refers to reporting of REDD+ reference levels and ERs, while the FCPF CF, ART-TREES and VCS-JNR refer to carbon accounting.

1.2.1 Modalities and procedures for REDD+ reporting

Reference levels can be submitted for technical assessment (TA), which happens once per year. The TA results in the publication of a TA report on the UNFCCC website. Since countries can make changes during the TA process, they often submit a modified reference level at the end of the TA process.

Countries may report **ERs in the technical annex of their** BUR. A BUR can be submitted at any time during the year and will undergo a technical analysis as part of the international consultation and analysis (ICA) process. From 2024, ERs may be reported in a technical annex to the **BTR** (see Section 6.1).

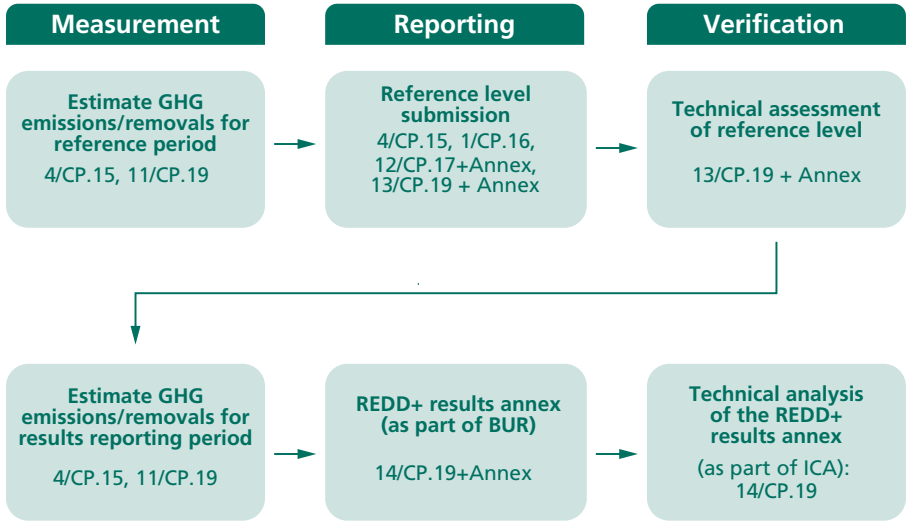

Figure 1. MRV for REDD+ and the most relevant decisions of the UNFCCC
Source: Authors' own elaboration

The **TA** of the submitted reference level will evaluate the extent to which the submission is in line with the guidelines contained in the relevant COP decisions. Once the TA has been completed, a TA report is published. Countries have the opportunity to propose changes as a result of the TA and submit a modified reference level. The time between reference level submission and the publication of the TA report is usually nine months to over one year. After the TA of the reference level is complete, countries can submit REDD+ results in an annex to their BURs for analysis (see Figure 1).

The UNFCCC secretariat has a maximum of six months to organize a **technical analysis** session after a country submits a BUR. The number of sessions depends on the number of submissions received. As of September 2022, a maximum of three sessions had been held during the year for the technical analysis of the BUR and REDD+ results in the technical annex (if a technical annex had been included). At the end of the technical analysis, a technical report is published on the UNFCCC website. Unlike the TA of reference level submissions, the technical analysis of REDD+ results does not foresee the submission of a modified BUR. Nonetheless, a number of countries make corrections to the text and submitted a modified technical annex of REDD+.

The procedure involved in the TA implies that a country cannot submit a reference level and REDD+ results at the same time. Countries are not required to make any changes as a result of the TA or technical analysis.

1.2.2 Status of UNFCCC reporting

As of September 2022, **56 countries** had submitted **75 reference levels** to the UNFCCC, including 20 countries in Latin America and the Caribbean, 20 in Africa, and 16 in Asia and the Pacific (see Figure 2).

Seventeen countries (Brazil, Cambodia, Colombia, Dominican Republic, Ecuador, Ghana, Honduras, Indonesia, Madagascar, Malaysia, Mexico, Nigeria, Panama, Paraguay, Peru, Suriname and Zambia) have submitted **more than one reference level** to the UNFCCC, for the following reasons: to expand the geographical scope; to cover more REDD+ activities; to update the reference level with new, improved data and an updated reference period; or a combination of the above.

Twenty-seven[1] submissions of **REDD+ results** were included in the technical annexes of the BURs of **18 countries** (see Figure 2). Brazil, Colombia, Argentina and Papua New Guinea submitted more than one technical annex with REDD+ results for the reporting of results of different subnational areas (the Amazon and the Cerrado for Brazil) and reporting subsequent results periods (all submissions).

Reference level submissions to the UNFCCC
Brazil
Colombia Ecuador Guyana Malaysia Mexico
Chile Congo Costa Rica Ethiopia Indonesia Paraguay Peru Viet Nam Zambia
Brazil Cambodia Côte d'Ivoire Ghana Honduras Madagascar Nepal PNG Sri Lanka Uganda United Republic of Tanzania
Brazil DRC India Lao PDR Madagascar Malaysia Mongolia Mozambique Myanmar Nigeria Panama Suriname
Argentina Bangladesh Guinea-Bissau Malaysia Nicaragua Nigeria Solomon Islands
Belize Bhutan Burkina Faso Colombia Dominican Republic Ecuador Equatorial Guinea Honduras Kenya Liberia Malawi Mexico Pakistan Sudan Togo
Colombia El Salvador Gabon Ghana Peru Saint Lucia Suriname Thailand Zambia
Dominica Dom. Republic Guatemala Indonesia Panama Paraguay
2014
2015
2016
2017
2018
2019
2020
2021
2022
Brazil
Colombia Malaysia Ecuador
Brazil
Chile Colombia Indonesia Paraguay
Brazil PNG Argentina Costa Rica
Uganda Lao PDR Cambodia
Honduras Brazil Viet Nam Belize Indonesia Gabon
Argentina PNG Mexico
UNFCCC REDD+ results:
11.5 billion t CO_2

Figure 2. Overview of REDD+ reference levels and results submitted to the UNFCCC by September 2022

Source: Authors' own elaboration

Note: Country names in italic indicate ongoing TA or technical analysis (the method and scope in the reference level may change as a result). Brazil's 2019 and 2021 BURs include two REDD+ results technical annexes (one for the Amazon and one for the Cerrado). DRC = Democratic Republic of the Congo; Lao PDR = the Lao People's Democratic Republic; PNG = Papua New Guinea; Dom. Republic = Dominican Republic.

[1] Brazil's latest BUR contains a technical annex with REDD+ results for the Amazon (2016–2017) and a technical annex with REDD+ results for the Cerrado (2011–2017), which here are considered as two REDD+ results submissions.

By September 2022, 66 of the 75 reference level submissions (**88 percent**) **had finalized the TA**. For 63 of the 66 assessed reference levels (95 percent), the country had submitted a modified reference level during the TA. Modifications range from changes in scope (adding or removing REDD+ activities, pools or gases), methodology and to merely changes in the submission text to enhance transparency. For 41 of the 66 technically assessed reference levels (62 percent), the reference level value was changed[2] as a result of the TA; 66 percent of the changed values resulted in a lower reference level value, while 34 percent of the changed values resulted in a higher reference level value.

By September 2022, 21 of the 27 REDD+ results submissions (**78 percent**) **had finalized the technical analysis**. Some countries had made corrections and improvements to the BUR TA text, after which a modified technical annex was published on the UNFCCC website. To date, no changes have been made to the submitted REDD+ result values.

1.3. OUTCOMES OF THE GLASGOW CLIMATE CHANGE CONFERENCE AND POTENTIAL FUTURE CARBON MARKETS

In November 2021, COP 26 delivered important progress for countries with active REDD+ programmes. Two of the highlights relate to progress towards operationalizing Article 6 and Article 13 of the Paris Agreement.

A major milestone was achieved when the **"Article 6 rulebook" was completed**, which could offer further context for national and subnational REDD+ going forward. Article 6 enables countries to cooperate towards their NDCs and provides **three distinct pathways:**

- the Article 6.2 cooperative approaches
- the Article 6.4 mechanism
- the Article 6.8 framework for non-market approaches

The approaches under Article 6.2 and Article 6.4 provide for **international carbon markets under the Paris Agreement**. Since there is no particular reference to REDD+ or the land-use sector, land use is as eligible as any other sector for participation. There is now **a framework for creating carbon credits**, so-called ITMOs **from REDD+ ERs**. ITMOs are measured in tCO_2eq, and their use for NDC offsetting is only possible if the host country expressly authorizes it and commits to carrying out a so-called **corresponding adjustment (i.e. subtracting ITMOs from its own mitigation results)**.

The process differs between Article 6.2 and Article 6.4. Under **Article 6.4, activities are to be proposed by host-country governments and/or the private sector. A supervisory body oversees the mechanism that directly reports to the UNFCCC**. Standardized methodologies will be developed and approved by the supervisory body and an audit-style verification will be undertaken. Under **Article 6.2, host-country governments approve activities and quantification methodologies**, potentially in partnership with

[2] A change in value of < 1 percent is considered no change here.

the private sector. There is no centralized supervision, but an expert review will be undertaken. Neither Article 6.2 nor Article 6.4 refer to the Warsaw Framework for REDD+ and related country reporting to the UNFCCC, nor is there a direct linkage to Article 5 (about the importance of REDD+ and related RBPs), which therefore also continue to serve as important contexts for REDD+.

The **new rules for Article 6 do not directly affect the voluntary carbon market**, which has come to represent an important context for jurisdictional REDD+ (see Section 2.1). So far, carbon credits traded in the voluntary carbon markets are not usable for NDC-offsetting, but only usable in the context of voluntary corporate commitment. Because of this, they do not usually come with a corresponding adjustment that a host-country authorization under Article 6 would entail.

In addition to giving a new role to carbon markets, Article 6 also highlights the importance of **non-market approaches to cooperation under Article 6.8**. Such non-market approaches may include RBPs, which have been the chief means of international cooperation surrounding REDD+ in recent years, as also reflected in Article 5. RBPs are payments in recognition of mitigation progress and do not concern a purchase of an ER or the transfer of a mitigation outcome.

Another major milestone achieved in Glasgow relates to **more details surrounding Article 13 of the Paris Agreement** that lays out the ETF. The Katowice Climate Package (COP 24) has provided the **rulebook** for implementing the ETF under the Paris Agreement, known as modalities, procedures and guidelines (MPGs) contained in Decision 18/CMA.1 (see Section 6.1). At Glasgow, **more recent guidance for operationalizing** the MPGs contained in Decision 5/CMA.3 are now available**.** Under the ETF, REDD+ results are to be reported as a technical annex to the BTR, instead of a technical annex to the BUR.

The critical role of forests was emphasised with the Glasgow leaders' **declaration on forests and land use**, where 145 signatories (covering > 90 percent of global forest) committed to working collectively to halt and reverse forest loss and land degradation by 2030.

Finally, the Glasgow Climate Pact welcomed the **beginning of the GST**, a process aiming to assess the world's collective progress towards achieving the purpose of the Paris Agreement and its long-term goals (Article 14), and will play a critical role in enhancing ambition in the next round of NDCs. Reporting of REDD+ results, along with the strongest scientific evidence on the outcomes of national and subnational REDD+ initiatives to date, will be critical to the collective assessment of progress in the land use, land-use change and forestry (LULUCF) sector.

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2. REDD+ results-based payments

The most frequently mentioned objective in reference level submissions is to gain **access to RBPs**. According to UNFCCC Decision 9/CP19, **RBPs may come from a variety of sources** (public and/or private; bilateral and/or multilateral), including alternative sources. A **key role is assigned to the GCF**, an operating entity of the financial mechanism under the UNFCCC (Decision 7/CP.21, paragraphs 23–25).

2.1. SUMMARY OF REDD+ RESULTS-BASED PAYMENTS DISBURSED TO DATE AND EMERGING OPPORTUNITIES

Decision 9/CP19 proposed the establishment of an Information Hub on the UNFCCC REDD+ web platform, where countries can report achieved ERs and RBPs received with the aim to increase transparency. As of September 2022, the **UNFCCC Info Hub** listed 12 countries, of which 7 (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador and Indonesia) are listing quantities of ERs for which payments were received and the entities paying for results. In total, the Info Hub listed **386 million tCO_2eq of ERs** to have been **awarded RBPs** for results achieved between 2006 and 2016. The Info Hub does not show all countries that have submitted ERs in their BUR technical annex, but only those that have finalized the technical analysis, have a technically assessed reference level, submitted their summary of information on safeguards, provided a link to the national strategy or action plan, and included information on the NFMS in the BUR technical annex. The Info Hub only lists ER quantities that recipient countries report to have been awarded RBPs and is therefore not necessarily complete.

To date, **bilaterals (or trilaterals) have provided the largest amount of RBPs** beyond the GCF RBP pilot programme. Examples of such programmes are the REDD Early Movers programme (REM, 2022), Norway's International Climate and Forest Initiative (NICFI, 2022), and Japan's Joint Crediting Mechanism (JCM, 2022). However, since these programmes are not open to all countries and detailed information on the additional requirements or arrangements are not always in the public domain, they are not further discussed or analysed in this publication. This publication also excludes project-level REDD+. The remainder of this publication will discuss reference level design choices by countries participating in programmes that are or were

open to many countries at the time of their creation, including: the **GCF RBP pilot programme** (even though its envelope is currently depleted); the **FCPF CF** (even though it is no longer open to new submissions); and **ART-TREES** and **VCS-JNR** (even though no RBPs have been made yet through these standards). It is important to note that ART-TREES and VCS-JNR are different from the GCF and FCPF in that they are not in themselves funds or sources of finance; the carbon credits certified with these standards can be sold through some associated sources of finance (see Table 1) or on the carbon market.

Table 1 provides an **overview of the different existing REDD+ jurisdictional RBP programmes or standards** covered in this publication and also identifies whether or not they are associated with a specific source of finance and whether they create carbon credits for markets.

TABLE 1.
Overview of different REDD+ standards or programme conditions

Managed by	Source of finance	Requirements	Context
GCF secretariat	GCF (volume limited and price predetermined) but envelope currently depleted	Scorecard	Financial mechanism of the UNFCCC for non-market RBPs
ART secretariat	Carbon market For some of the credits: LEAF, CORSIA	TREES v2.0	Carbon standard for jurisdictional REDD+ for market-based and non-market RBPs
Verra secretariat	Carbon market For some of the credits: CORSIA	VCS-JNR v4	Carbon standard for jurisdictional REDD+ for market-based RBPs
FCPF secretariat	FCPF CF (volume limited and price predetermined) Potentially carbon market [a]	FCPF methodological framework	Carbon standard for jurisdictional REDD+ for piloting market-based and for non-market RBPs

[a] Selling FCPF CF credits on the (voluntary) carbon market is not a primary objective but could be done.

This publication focuses on different MRV requirements and MRV choices countries participating under the mentioned programmes included in their reference levels and REDD+ results (see Section 5.1). However, **there are other important differences among the standards or programmes** that countries need to consider when selecting the standard or programme that is best aligned with their objectives, some of which are described in Box 2.

Box 2
Legal requirements under different results-based payments programmes or standards

In order to access climate finance, either from RBPs under public schemes or voluntary carbon markets, forest countries need to comply with legal requirements, often involving clarity on various dimensions of rights over ERs (i.e. who holds title to ERs or carbon rights, who has the right to transfer them, and who has the right to benefit from the proceeds).

Table 2 shows how these issues are addressed under the GCF RBP pilot programme, the FCPF CF, ART-TREES, and VCS-JNR.

TABLE 2.
Description of legal requirements related to ER rights (carbon rights) for different REDD+ RBP standards or programmes

GCF RBP pilot programme	Section F, "legal title to REDD+ results," of the pilot programme for REDD+ RBPs requires developing countries to: "(i) provide an analysis with respect to legal title to REDD+ results in the country. This should include an analysis of entitlement to claim for the results to be paid for by the GCF and (ii) covenant that no other party has a competing claim to the results proposed to the GCF in accordance with national policy, legal or regulatory frameworks." GCF REDD+ Portal: See projects approved (Section F of the projects, dealing with REDD+ title) www.greenclimate.fund/redd
FCPF CF	"Submit evidence demonstrating the program entity´s ability to transfer title to ERs, free of legally recognized interests, encumbrance or claim of a third party and provide a tentative risk rating that this ability is clear or uncontested. As part of this demonstration, include a discussion on the implications of the land and resource regime on the ability to transfer title to ERs to the FCPF CF. The ability to transfer title to ERs may be demonstrated through various means, including reference to existing legal and regulatory frameworks, sub-arrangements with potential land and resource tenure rights-holders (including those holding legal and customary rights), and benefit-sharing arrangements under the Benefit-Sharing Plan." Refer to criterion 28, indicator 28.3 and criterion 36, indicator 36.2 and indicator 36.3 of the methodological framework FCPF CF – ERPD Template Section 17.2 Transfer of ER titles www.forestcarbonpartnership.org/requirements-and-templates

ART-TREES	"Provide a brief summary of the Participant's rights to the emissions reductions and removals generated from the accounting area (regulatory frameworks, laws or administrative orders) or a description of how rights will be obtained in accordance with domestic law. It may not be necessary for the Participant to establish or enact new legislation or a legal framework to address carbon rights. However, the Participant must explain how, under existing constitutional or legal frameworks, carbon rights and/or related intangible property interests, are established and addressed. This explanation should include how such carbon rights and/or intangible property interests would be established, the legal basis for creating such rights and interests, and how claims to such rights from private parties, Indigenous Peoples or subnational entities will be resolved (consistent with applicable UNFCCC Cancun Safeguards and Section 12.0 herein). To address the latter, the Participant must describe any agreements in place or that will be in place, for the transfer of TREES rights or benefit allocation arrangements with landowners/resource rights holders that exist between the Participant and project owners, landowners and/or other collective rights holders (including indigenous peoples and other traditional communities). TREES will only be issued that have demonstrated clear ownership or rights. Participants may provide this demonstration at a later date, within the same crediting period or during a subsequent crediting period (provided the crediting periods are adjacent)." The REDD+ Environmental Excellence Standard (TREES) www.artredd.org/wp-content/uploads/2021/12/TREES-2.0-August-2021-Clean.pdf p.81
VCS-JNR	Jurisdictional programs can only be registered by jurisdictional proponents that have the legal authority to adopt REDD+ policies and measures at the jurisdictional level. Updated language to the Authority and Rights to ERs section (previously Program Ownership) to reflect that jurisdictional proponents must demonstrate how jurisdictional rights relate to the rights of non-state stakeholders including indigenous peoples, local communities, private entities and individuals, and how the rights of existing and any future nested projects or programs will be respected. Jurisdictional and Nested REDD+ (JNR) Requirement under VERRA JNR_Version_4_Summary_Updates_and_Effective_Dates.pdf (verra.org)

A national legal definition of ER titling is not considered to be a precondition to accessing RBPs under the GCF, nor is it necessary to transfer the ownership of the ERs to the GCF itself; rather, it is necessary to guarantee that no competing claims to ownership of these reductions will overlap with the results that would be compensated by the GCF, and that ERs covered by the proposal will not be transferred and/or used for any other purposes, including offsetting through the voluntary market.

All standards or programmes listed above have the following two factors in common: the need to respect REDD+ social and environmental safeguards, including documentation of how this will be achieved and demonstrated; the development of a benefit sharing plan, including benefit allocation agreements established with relevant beneficiaries of the implementation of REDD+ strategies, policies and measures, taking into consideration participatory and inclusive processes.

Table 3 shows the RBPs under the standards or programmes made as of September 2022. They concern payments under the GCF RBP pilot programme and FCPF CF, which both concern funds with a fixed price (see Table 1). No market-based transaction has yet occurred for jurisdictional REDD+ on the voluntary carbon market.

TABLE 3.
Summary of RBPs under different standards or programmes

	GCF RBP	ART-TREES	FCPF CF
Number of countries participating[a]	12	13	15
Number of countries submitting ERs for RBPs[b]	8	1	5
Average deduction (difference offered ERs and ERs for payment)	22%[c]	15%[d]	24%[e]
Total ERs that qualify for payment (i.e. after deduction)	104 million tCO_2eq	35 million tCO_2eq[d]	56 million tCO_2eq[e]
ERs for which payment was received	97 million tCO_2eq	-	4.6 million tCO_2eq
RBPs disbursed to date	USD 497 million	No payments yet	Initial payments of USD 22.8 million
Price	USD 5/tCO_2eq	To be determined	USD 5/tCO_2eq

Notes: a) For the GCF RBP pilot programme, this is assessed as the number of countries that submitted a concept note with all requirements in place; for ART-TREES, this reflects the countries submitting one or more concept notes; for the FCPF CF, this reflects the countries that signed an emission reduction payment agreement (ERPA).

b) For the GCF RBP pilot programme, this reflects the number of funding proposals submitted; for ART-TREES and the FCPF CF, this reflects the number of monitoring reports submitted that are publicly available (e.g. for the FCPF CF, two additional countries submitted a monitoring report, but since these are not yet available, they are excluded).

c) This is the average of the percentage deduction per country, rather than a weighted average. All GCF RBP programmes received a 2.5 bonus for non-carbon benefits (when taken into consideration, one could say the average deduction was 19.5 percent, instead of 22 percent). Mitigating mechanisms for the risk of reversals in the form of set aside volumes are not considered here.

d) This information is from one country (Guyana) only and therefore may not be fully representative. The deduction has been calculated by the country applying ART-TREES but has not yet been validated or verified. The country applies the high forest, low deforestation (HFLD) modality in ART-TREES.

e) This information is from six submissions of which only three finalized the verification and validation; this number can change as a result of the verification and validation.

2.2. THE GREEN CLIMATE FUND'S RESULTS-BASED PAYMENTS PILOT PROGRAMME

2.2.1 The Green Climate Fund's results-based payments process

In October 2017, the GCF launched a pilot programme for REDD+ RBPs (GCF Board Decision B.18/07), which offered RBPs for ERs achieved over the five-year period 2014–2018 (i.e. January 2014–December 2018) for countries that have measured, reported and verified ERs (Dec 13/CP19 and 14/CP19) and have all REDD+ elements (Dec 1/CP16p71) in place.

Under the pilot programme, countries that submitted REDD+ results in their BUR TA to the UNFCCC could apply for RBPs through the GCF if they met the specific GCF RBP pilot programme requirements (GCF, 2017). The GCF required funding to flow through **accredited entities** that worked together with governments to develop proposed investments. Countries that wished to receive REDD+ RBPs therefore needed to engage with an accredited entity.

To apply for GCF RBPs, the accredited entity submitted a **concept note** with a letter of support from the country's REDD+ focal point and/or nationally designated authority (NDA) to the GCF, which was assessed by the secretariat against a first stage scorecard (containing the programme's eligibility criteria). Concept notes fulfilling the criteria were invited to submit a complete RBP funding proposal.

A **funding proposal** was submitted by the accredited entity, along with a set of compulsory annexes, including a no objection letter from the NDA. The proposal was then assessed by the GCF secretariat against a second stage scorecard, aimed at assessing qualitative aspects and consistency of carbon and non-carbon elements. The **scorecard** (GCF, 2017) "translated" the volume of UNFCCC reported ERs offered by the country into a "GCF volume of ERs" (i.e. ERs for which payments could be received). The scorecard also contained "fail" elements, indicating when the reported ERs were not eligible for receiving payments from the programme. In addition to the limits on the GCF payable volume, over the span of the pilot programme, some countries explicitly established mitigating mechanisms for the risk of reversals in the form of set aside volumes, further reducing the share of payable volumes in relation to the country's total ER available to offer to the GCF. On completion of this appraisal process and endorsement of the proposal by the GCF secretariat, the proposal was assessed by an independent technical advisory panel (iTAP), common with all other GCF funding proposals. The board considered RBP funding proposals based on the secretariats' assessment and the recommendations from the iTAP.

2.2.2 Status of the Green Climate Fund's results-based payments

By September 2022, **12 concept notes** with REDD+ elements in place had been submitted to the GCF RBP programme, and 8 of the 12 were followed by funding proposal submissions that received RBPs. The concept notes were awarded RBPs on a first-come, first-served basis, but only entered the pipeline after successful assessment against the first stage scorecard (e.g. despite early submission, Peru's concept note did not enter the pipeline, since REDD+ results were not submitted). The four concept notes that were submitted with all elements in place but did not receive RBPs (as of September 2022) due to the depletion of the pilot phase envelope, were Papua New Guinea (submitted in December 2019), Viet Nam (submitted in September 2020), the Lao People's Democratic Republic (submitted in September 2020), and Uganda (submitted in March 2022). While the **time period** between GCF RBP concept note submission and RBP disbursement may appear to be short (see Figure 3), the full process would start with the UNFCCC submission of a reference level and subsequent REDD+ results submission in the BUR TA.

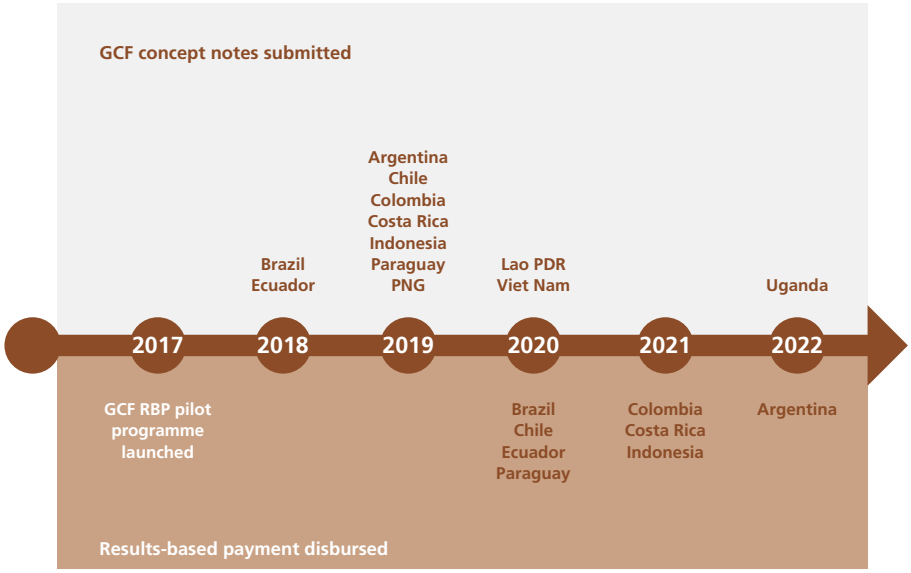

Figure 3. Overview of GCF RBP concept note submissions and disbursements by September 2022

Source: Authors' own elaboration

Note: The graph only considers concept note submissions where all requirements are in place; as such, Peru's 2018 submission is not included here. Lao PDR = the Lao People's Democratic Republic; PNG = Papua New Guinea

By September 2022, the GCF had approved the funding proposals of **eight countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Indonesia and Paraguay)**. Deductions were applied to the total ERs offered

to the programme through the scorecard score (see Table 4). The total volume of REDD+ results offered to the GCF programme by the eight countries is 133 million tCO_2eq ERs, of which 104 million tCO_2eq (78 percent) qualified for payments, translating to an average **deduction of 22 percent** of the offered ERs. All countries received an additional 2.5 percent of payments for use of proceeds and non-carbon benefits. Many countries offer only a fraction of the ERs reported to the UNFCCC to the GCF RBP pilot programme (see Section 5.2).

TABLE 4.
ERs offered and RBPs granted under the GCF RBP pilot programme as of September 2022

	ERs offered (million tCO_2eq)	ERs qualified for payments (million tCO_2eq)	Scorecard score	RBPs granted (USD)
Argentina	21.9[a]	18.7	41/48 = 0.85	82 000 000
Costa Rica	14.1	10.6	36/48 = 0.75	54 119 143
Brazil	25.1	18.8	36/48 = 0.75	96 452 228
Chile	14.5[b]	12.4	41/48 = 0.85	63 607 552
Colombia	6.9	5.5	38/48 = 0.79	28 208 122
Ecuador	4.8	3.6	36/48 = 0.75	18 571 766
Indonesia	27.0	20.3	36/48 = 0.75	103 781 250
Paraguay	18.9	14.1	36/48 = 0.75	50 000 000[c]
Total	133.3	104.0		496 740 060

Notes: [a] The funding proposal mentions that 18.7 million tCO_2eq ERs were offered to the GCF, but that is the amount after applying the scorecard score; we calculate the amount before application to be consistent with the reporting by other countries of the "offered" amount. An additional 7 492 683 tCO_2eq is set aside as an interim mechanism to manage risks of reversals.
[b] In addition, a reserve fund of 3 862464 tCO_2eq is established as a buffer for reversals (as a result of the analysis of the reversal risk potential).
[c] The full volume worth a RBP of USD 72 million has been approved but UNEP's accreditation allows a maximum of USD 50 million per project only. As such, the project is for USD 50 million and Paraguay may choose to present a subsequent proposal for these remaining funds at a later board meeting.

2.2.3 The future of ther Green Climate Fund's results-based payments

By the end of 2020, the funding envelope of the GCF RBP pilot programme had been fully allocated and it is not clear whether it will be extended as a regular programme and under which terms of reference. As one of the financial mechanisms of the UNFCCC, the **GCF continues to play a key role in contributing to the provision of adequate and predictable RBP** in a manner consistent with the methodological aspects agreed upon by the Parties through Article 5.2 of the Paris Agreement, aiming to increase the number of countries with access to secure RBPs. As included in Decision 6/CP.26, paragraph 13, the COP asked the GCF to expedite a new arrangement

for REDD+ RBP, specifically "urg[ing] the Board to finalize in a timely manner its work related to the guidance and arrangements of the COP on financing for forests."

In February 2020, the GCF published a mid-term review (GCF, 2020a) outlining a series of lessons learned in relation to the technical elements of the programme. The GCF board requested that the GCF secretariat further analyse alternatives for the continuation of the programme, while acknowledging diverging opinions amongst GCF board members concerning the future of RBPs under the GCF and highlighting the high demand from countries and COP's guidance concerning the operationalization of RBPs for forests under the Paris Agreement. Consistent with this request, informal discussions were undertaken, including: 1) interviews with interested members of the board and observers; 2) preparation of a background document summarizing key issues identified during the interviews; 3) expert meetings to discuss the key issues identified; and 4) a call for inputs on some of the more detailed elements of the terms of reference for the next phase of REDD+ RBP under the GCF. As of September 2022, there was no replenishment of the pilot phase and a decision on a subsequent phase of the GCF RBP programme is still under discussion. As such, **the future of** REDD+ RBPs under the GCF remains unclear.

Meanwhile, there are other opportunities for REDD+ RBPs beyond the GCF for national and subnational jurisdictions.

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3. Voluntary carbon market

The voluntary carbon market has seen significant growth since 2016 (Forest Trends' Ecosystem Marketplace, 2021). The year 2021 was a historic, record-breaking year for the voluntary carbon market, driven by nature-based solutions and rising prices; 2022 is off to a fast-paced start (Forest Trends' Ecosystem Marketplace, 2022), and this growth is expected to continue for years to come (Forest Trends' Ecosystem Marketplace, 2021, 2022).

Recently, two standards for jurisdictional REDD+ were published: the **Architecture for REDD+ Transactions' – The REDD+ Environmental Excellence Standard Version 2 (ART-TREES v2.0)** came out in August 2021 (ART, 2021), and the **Verified Carbon Standard – Jurisdictional and Nested REDD+ Version 4 (VCS-JNR v4)** came out in April 2021 (Verra, 2021a). These standards seek to catalyse this finance through new or updated jurisdictional approaches that are viewed as being preferable for carbon markets. They have MRV requirements beyond the UNFCCC specifications to **ensure high-quality ERs** and have an audit-style verification process. Other than MRV, they also include verification of environmental, social and governance safeguards, as well as proof of ownership of ERs, which are not required by the UNFCCC.

Some of the jurisdictional REDD+ credits verified under ART-TREES or VCS-JNR **are eligible for the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).**[3] Due to the impact of COVID-19 on aviation emissions, the offset demand during the 2021–2023 pilot phase is expected to be negligible; however, for the first time, REDD+ credits are included in the international compliance market, which can be considered a strong signal to the market regarding the potential opportunity of jurisdictional REDD+ (Forest Trends' Ecosystem Marketplace, 2021). Another indication of **rising opportunities for jurisdictional REDD+** is the April 2021 announcement of a public–private sector partnership named the Lowering Emissions by Accelerating Forest finance (LEAF) coalition (see Box 3), committing to pay 100 million tCO_2eq for ART-issued REDD+ ERs (TREES credits) at a minimum price of USD 10 per tCO_2eq.

The context of REDD+ reporting has evolved significantly and countries with active REDD+ programmes find themselves often reporting and accounting in several different contexts. The next section will provide an overview of the different reporting and accounting procedures for market-based REDD+.

[3] Eligible unit dates are 2016–2023 for ART-TREES and 2016–2020 for VCS-JNR (ICAO, 2022).

Box 3
The LEAF coalition

LEAF is a public-private effort to protect tropical forests and reduce deforestation (LEAF, 2022). It was launched in April 2021, at the Leaders' Summit on Climate, mobilizing USD 1 billion for REDD+ ERs. The coalition includes the governments of Norway, the United States of America, and the United Kingdom, as well as more than 20 private companies. To participate, private companies must publicly commit to science-based targets (The Science Based Targets initiative, 2022), or the equivalent of quantified and independently verified decarbonization targets, no later than 2023. The proposal submission window is for REDD+ ERs from crediting years 2022–2026, with a floor price of USD 10 per tCO_2eq. ERs must be validated and verified against the ART-TREES requirements. The first call for proposals was in 2021, after which 23 jurisdictions completed an initial technical screening process led by a panel of technical experts. The second call for proposals was in 2022, closing in mid-September of the same year.

LEAF is coordinated by Emergent, a non-profit intermediary engaging between tropical forest countries and the buyers to mobilize finance for REDD+ results. Emergent's support includes intermediary services for transactions, as applicable, and post-transaction infrastructure for partners that choose to make transactions through Emergent. At COP 26, Emergent signed a letter of intent (LOI) with five jurisdictions (Costa Rica, Ecuador, Ghana, Nepal and Viet Nam), indicating an interest to sign additional agreements soon (Emergent, 2021a).

4. Different REDD+ accounting processes and current status

4.1. FCPF CARBON FUND ACCOUNTING PROCESS

The FCPF CF became operational in 2011 to pilot incentive payments for REDD+ efforts in developing countries. Its pipeline has been closed for some years now, but was previously open to those countries that had prepared a readiness preparation proposal and had their readiness package (R-Package) endorsed by the participants committee under the Readiness Fund (financed by donor governments). The World Bank was the trustee of the FCPF's Readiness Fund and carbon fund (CF) and provided secretariat services through a **facility management team (FMT)**. Under the FCPF CF, the process started with the submission by an FCPF REDD+ country participant[4] (or an authorized entity) of an initial proposal known as **emission reductions programme idea note (ER-PIN),** which included, among other things, a brief description of a draft reference level and expected ERs. The FMT reviewed the ER-PIN and assessed whether it fulfilled the conditions to be accepted in the pipeline. After a REDD+ country participant was accepted in the pipeline, a **LOI** was signed between the country (or authorized entity) and the World Bank. The LOI required its parties to negotiate an emission reductions payment agreement (ERPA) in good faith based on exclusivity for a certain period.

An **emission reductions programme document (ERPD)** was prepared by a REDD country participant (or its authorized entity) with technical support from the World Bank and presented the organizational and technical aspects (including the description of the reference level) of the ER programme and the ER programme measures in accordance with the methodological framework. The ERPD was subject to a completeness check by the FMT prior to an independent assessment conducted by the **technical advisory panel (TAP)** against the FCPF methodological framework (FCPF 2016, 2020). Once the final ERPD was reviewed and accepted into the FCPF CF portfolio, an **ERPA** was negotiated and signed between the participants and the World Bank for the sale, transfer of, and payment for ERs generated from the ER programme with a formal letter of approval for the ER programme issued by the national authority (FCPF, 2021a).

A REDD country participant (or its authorized entity) officially reported on its performance to the FCPF CF by submitting an **ER monitoring report**

[4] An FCPF REDD+ country participant is a developing country located in a subtropical or tropical area that has signed a participation agreement to participate in the Readiness Fund. Forty-seven developing countries have been selected to join the FCPF.

(containing the REDD+ results) to the FMT for a completeness check within forty-five calendar days following the end of each reporting period (or as agreed upon with the World Bank). The ER monitoring report was then assessed by the **validation and verification body (VVB)** and a validation and verification report prepared subject to a technical review. The final validation and verification report was reviewed by the FMT and published on the FCPF website together with the ER monitoring report. Both the ER monitoring report and the validation and verification report were then submitted to the Carbon Asset Tracking System.[5] The FMT determined and notified the REDD country participant of the amount of generated and verified ERs. ER units (after issuance) could also be allocated in buffer accounts to help manage both uncertainty and reversal risks.

The World Bank is developing a **Climate Emissions Reduction Facility (CERF)**, which will incorporate jurisdictional REDD+. This facility could provide continuation of the FCPF CF and the BioCarbon Fund Initiative for Sustainable Forest Landscapes (BioCF ISFL). BioCF ISFL is not discussed in this publication as it covers more than REDD+ ERs and only a few selected countries are included in the programme.

4.2. STATUS OF FCPF CARBON FUND ACCOUNTING

As of September 2022, **15 countries** had signed an ER payment agreement for a total **ER contract volume of 144 million tCO_2eq** (FCPF, 2022a). All 15 countries had submitted ERPDs[6] including a reference level.

The FCPF process allows countries to propose **technical corrections and/or improvements to its reference level** in the monitoring report.

By September 2022, **seven countries** had reported REDD+ results through **eight submissions** (in their ER monitoring reports to the FCPF CF) (see Figure 4) (FCPF, 2022b). Of these eight submissions, only six (from five countries) were publicly available by September 2022, including their respective ER volume. The combined ERs reported by these five countries (Costa Rica, Ghana, Indonesia, Mozambique [with two submissions], and Viet Nam) total **104 million tCO_2eq ERs**, of which **70 million tCO_2eq were offered to the FCPF** (the difference is mainly explained by the ERPA covering a shorter period[7]). After deductions, the offered 70 million tCO_2 were converted to

[5] The Carbon Assets Tracking System (CATS) is an online transaction registry that issues, records, transfers and tracks the carbon units that are exchanged within market mechanisms or financed through results-based initiatives such as the FCPF CF. CATS is designed and implemented to support the issuance and transactions of ER units generated under the World Bank Programs to avoid double counting.

[6] **Eighteen countries** had submitted reference levels in their ERPDs that were selected into the portfolio of the FCPF CF; however, three countries abandoned the programme.

[7] The FCPF CF requires countries to report REDD+ results over full calendar years but the payments under ERPAs tend to start at the date of ERPA signature, which can be any date during the year. As such, it is common for countries to report REDD+ results over a longer period than the share they offer to the FCPF CF for conversion into FCPF ERs; however, countries may include more ERs than those covered by the ERPA (see Mozambique's example).

56 million tCO$_2$eq FCPF ERs (i.e. creditable ERs). Figure 4 does not show the full timeline for FCPF CF submissions as these could be considered to start with the submission of the ER-PIN. The ER-PIN was submitted by Mozambique in 2008 and their first payment was received in 2021.

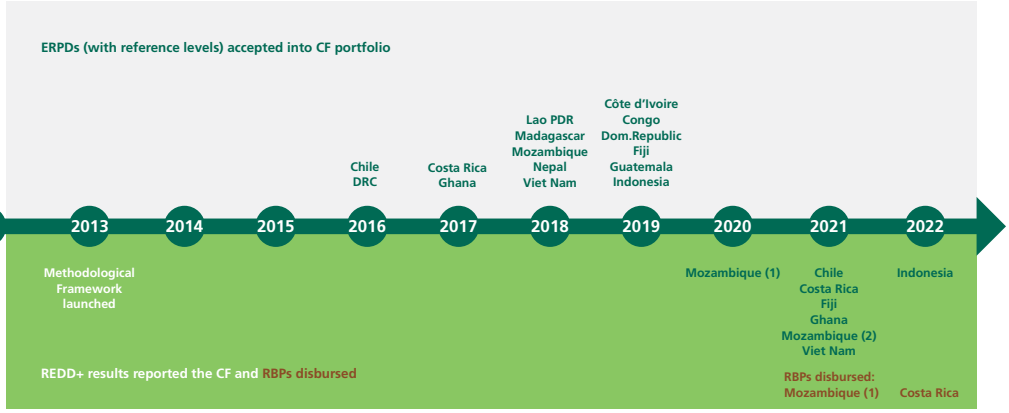


Figure 4. Overview of reference levels and REDD+ results submitted to the FCPF CF by September 2022

Source: Authors' own elaboration

Note: Mozambique 1 refers to the first monitoring report with REDD+ results for the year 2018; Mozambique 2 is the second monitoring report with results for the years 2019 and 2020. Dom. Republic = Dominican Republic; DRC = Democratic Republic of the Congo; Lao PDR = the Lao People's Democratic Republic

By September 2022, **three monitoring reports** (Mozambique, Costa Rica, and Ghana) had successfully **concluded the validation and verification process**. All presented a final monitoring report, in which the FCPF ERs were modified. Mozambique's FCPF ERs increased because the country extended its crediting period to include all of 2018 instead of only including the months covered by the ERPA. The certified FCPF ERs preceding the ERPA may be sold through auction on the voluntary carbon market. Costa Rica's FCPF ERs decreased possibly temporarily as part of the ERs are under legal analysis. Ghana's FCPF ERs decreased due to a change in accounting of emissions from soil organic carbon, where Ghana replaced the initial assumption of instant full emissions from soil ("committed" emissions) and instead applied the FCPF guidance note on legacy emissions and removals (FCPF, 2021b). The achieved ERs from soil can still be reported under subsequent reporting periods (the guidance note application results in the same amount of ERs from soil; only the ER reporting is delayed).

As per September 2022, Mozambique had received **RBPs of USD 6.4 million** (1.28 million tCO$_2$) from the FCPF CF, while Costa Rica had received **RBPs of USD 16.4 million** (3.28 million tCO$_2$) from the FCPF CF.

4.3. ART-TREES ACCOUNTING PROCESS

The process to enter "Architecture for REDD+ Transactions (ART)" using TREES requires approval of a TREES concept. Jurisdictions then prepare a TREES registration document and a TREES monitoring report to undergo initial validation and verification; if the audit is successful, the ART Board must then approve the issuance of TREES credits. A **TREES concept** includes preliminary information about the proposed participant (a national government entity or an eligible subnational government no more than one administrative level below the national level) and demonstrates how the proposed participant meets the eligibility criteria (it does not include a reference level). Information contained in the TREES concept is based on information available at the time of submission and will likely change during development of the TREES registration document, as more detailed analyses and calculations are conducted. The ART secretariat will review the TREES concept for completeness and conduct general eligibility screening; however, approval of the TREES concept does not constitute formal ART registration or formal validation or verification of the submitted information. Following approval, the participant's TREES concept is referenced in the ART registry as "listed".

Once the participant is ready to proceed, they submit the **TREES registration document** (containing, among other components, the reference level) and the initial **TREES monitoring report** (containing the REDD+ results) to the secretariat for a completeness check. The ERs quantified by the participants are subject to several deductions to ensure the integrity of the issued credits (i.e. creditable ERs). The deductions are quantified based on the risk of reversals (using an assessment tool), risk of leakage (assessed based on the percentage of the national forest area included in the accounting area), and the uncertainty around the ERs (assessed using a Monte Carlo simulation).

The secretariat conducts a completeness check of the TREES registration document and the TREES monitoring report. Once approved, the documents are posted on the ART registry and the public comment period begins. The participant then moves forward with **validation and verification**. The VVB conducts a conflict of interest assessment; once it is completed, they begin the validation of the TREES registration document and the verification of the TREES monitoring report. The ART secretariat reviews the reports from the VVB. If the audit is successful, the ART secretariat submits the participant's final package and a recommendation to the ART board for approval. Upon approval by the ART board, the participant's TREES registration document and monitoring report are referenced in the ART registry as "registered" and **TREES credits are issued** based on the completed verification. If the participant has demonstrated conformance with the high forest/low deforestation (HFLD) criteria and used the optional HFLD crediting approach, TREES credits issued will be labelled as HFLD. If the

participant has used the optional removals crediting approach, these TREES credits will be labelled as removals in the ART registry.

4.4. STATUS OF ART-TREES ACCOUNTING

As of September 2022, **15 jurisdictions** located in 13 countries have submitted a **TREES concept** (see Figure 5) (ART, 2022). Figure 3, Figure 4 and Figure 5 attempt to provide an overview of submissions in the context of REDD+ RBPs; however, it is important to note that they show different aspects of diverse processes and are not directly comparable. ART-TREES (see Figure 5) may appear to be moving much more quickly, but it should be considered that this is building upon previous readiness efforts by countries and processes established by the UNFCCC and pilot programmes, such as those from the FCPF CF and GCF.

One country (Guyana) submitted a reference level (in its ART-TREES registration document) and REDD+ results (in an ART-TREES monitoring report). The submitted REDD+ results are from a HFLD country and assessed against an adjusted reference level. They cover the five-year period 2016–2020 and total **41.6 million tCO_2**.

After applying the deductions, the claimed ERs of 41.6 million tCO_2 are converted into **35.2 million tCO_2 TREES ERs** (85 percent of offered ERs). **Verification and validation is currently ongoing and the above reported numbers may change as a result of this process.**

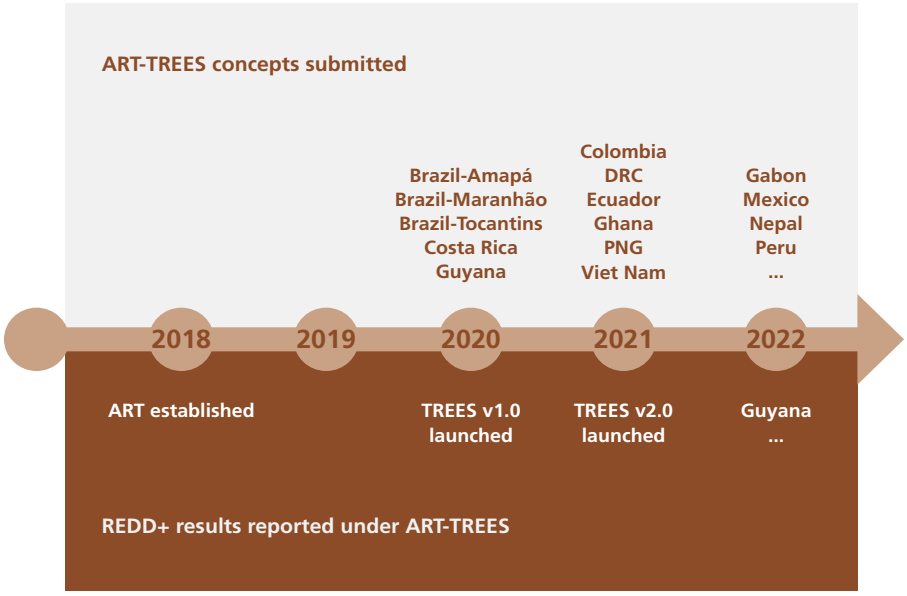


Figure 5. Overview of TREES concepts and REDD+ results submitted to ART (by September 2022)

Source: Authors' own elaboration

Note: DRC = Democratic Republic of the Congo; PNG = Papua New Guinea

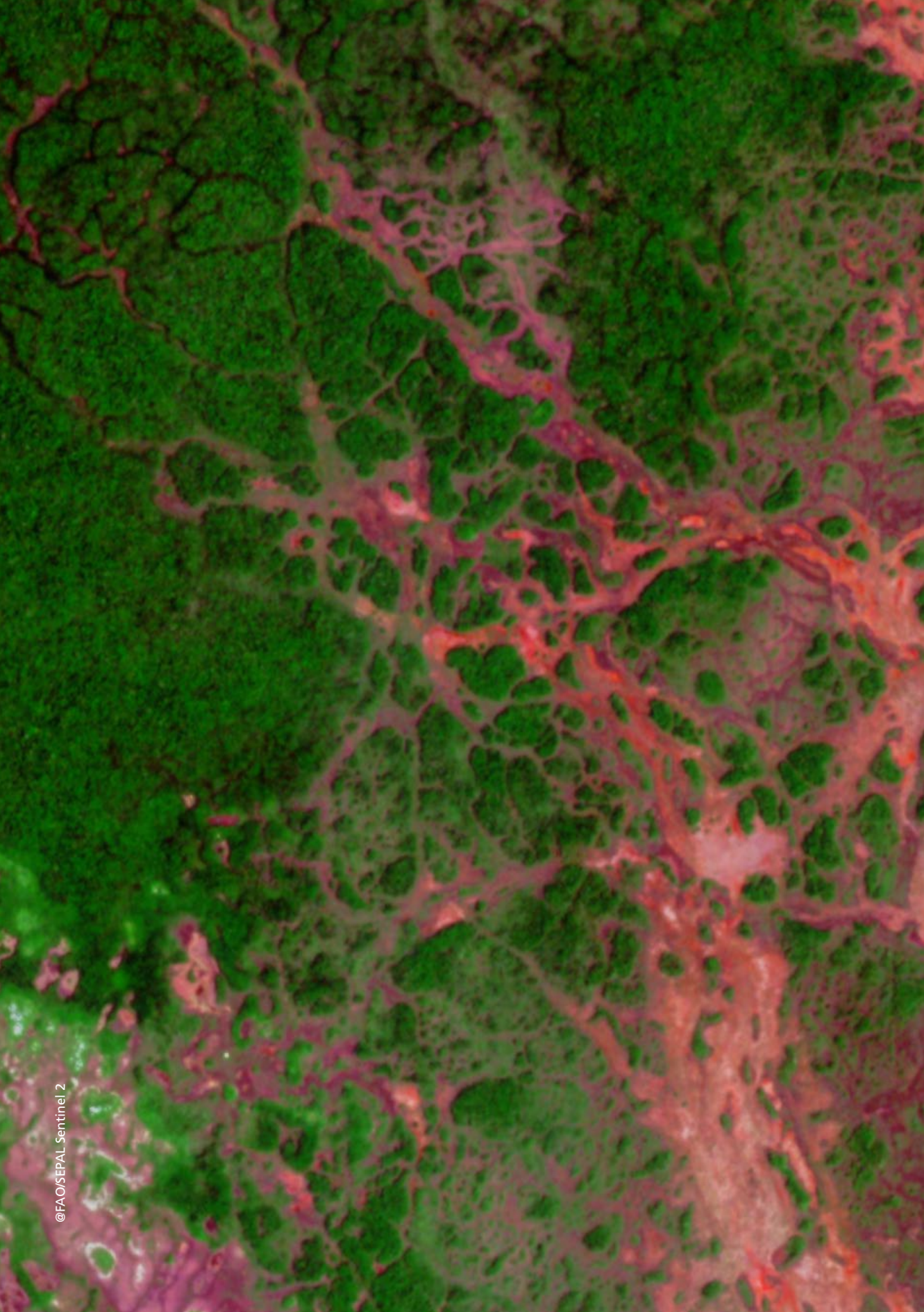
4.5. VCS-JNR ACCOUNTING PROCESS

The procedure for listing and registering jurisdictional programs under the VCS-JNR requires the jurisdictional proponents (i.e. government entities or agencies that qualify as jurisdictional proponents) to complete an **account application with the Verra registry**, a central repository system managed by Verra staff and accessible via the Verra website (Verra, 2021b). The application is reviewed by Verra and an account is opened upon approval. After opening an account, jurisdictional proponents can **submit jurisdictional element documentation** (jurisdictional reference level or jurisdictional programme documentation) **to be listed in the pipeline**. The Verra registry contains a pipeline that lists jurisdictional elements before they are registered for the purpose of stakeholder consultation. Upon submission, the documents are reviewed and approved by Verra and may be listed in the pipeline with a status as either "under development" (draft documentation, providing as much information as possible[8]) or "under public comment" (complete documentation). A 60-day **public comment period** shall be conducted, after which the pipeline status is changed from "under public comment" to "under validation". Accordingly, the VVB issues its **draft validation and verification report**. The next step is the **registration process**. When a jurisdictional element successfully completes validation, it may progress to registration initiated by the jurisdictional proponent. For registration followed by verified carbon unit (VCU) issuance (jurisdictional elements can be also submitted for registration in the VCS registry, but without VCU issuance), the jurisdictional proponent submits the following documentation to the Verra registry: **jurisdictional element description**, **validation report**, **validation representation**, **registration representation**, **monitoring report**, **verification report**, **verification representation**, **issuance representation** and other relevant documentation, as required. The jurisdictional element **review process** is triggered when the relevant documentation for registration and issuance is submitted to the Verra registry. Following the completion of the review process, **VCUs may be issued** upon request to the Verra registry at any time. The Verra registry performs automated checks and generates VCU serial numbers. The VCU issuance levy and any fees charged by Verra are payable on the volume of VCUs that are issued (not the total verification report volume). The VCU issuance levy shall be collected by Verra before VCUs are deposited into an account. The VCS programme addresses non-permanence risk associated with jurisdictional programs and project activities by requiring jurisdictional programs and nested projects to set aside non-tradable buffer credits to cover unforeseen losses in carbon stocks. The buffer credits from all jurisdictional programs and nested projects are held in a single jurisdictional pooled buffer account, which can be drawn upon in the event of a reversal in carbon stocks in any individual jurisdictional programme or nested project.

[8] The template does not have to be completely filled out and indicative information is sufficient (e.g. the complete set of data supporting a jurisdictional reference level that will be submitted for validation need not be specified).

4.6. STATUS OF VCS-JNR ACCOUNTING

As of September 2022, only one jurisdictional REDD+ programme account (from Myanmar) is listed in the pipeline (but not yet registered) in the VCS Registry. It contains a reference level for the Bago Region, an administrative region that is the second jurisdictional level below the national level.


@FAO/SEPAL Sentinel 2

5. Components of carbon accounting and reporting

5.1. REFERENCE LEVEL SETTING

This section briefly **summarizes country choices per reference level element**. Each section starts with a short overview of the different modalities and requirements from the UNFCCC, the GCF RBP pilot phase scorecard (which may change for future RBPs under the GCF), ART-TREES v2.0, VCS-JNR v4, and the FCPF MF.

Accordingly, the graphs summarize reference level elements in UNFCCC reporting (56 countries in total, where only the most recent elements are reflected), reference level elements in countries that received GCF RBPs or are in the pipeline (12 countries in total, noting these are included in the 56 countries under UNFCCC reporting), and reference level elements in countries that signed an ERPA under the FCPF CF (15 countries). To date, only one country (Guyana) has reported a reference level and REDD+ results under ART-TREES. The submitted ART-TREES concepts (15 jurisdictions) do not provide details on reference level elements, but do provide information on the scale; as such, this is the only graph (currently) where ART-TREES is included. The information on the elements of Guyana's ART-TREES reference level is noted in the text but excluded from the graphs, as a single submission is not considered a representative sample.

5.1.1 Forest definition

	Reporting modalities
UNFCCC	Countries **should provide the forest definition** they used for the construction of the reference level and explain **whether it differs from that used in the national GHG inventory or in reporting to other international organizations.**
	RBP requirements
GCF pilot phase scorecard	The scorecard assesses the consistency of the **reference level with the GHG inventory, including the definition of forest used**. If it is found not to be consistent, the score will be reduced (no fail).
FCPF MF	The definition of forest used in the construction of the reference level **is specified** by each country. If there is a difference between the definition of forest used in the national GHG inventory or in reporting to other international organizations (including a Forest Reference Emission Level or Forest Reference Level to the UNFCCC) and the definition used in the construction of the Reference Level, then the ER programme **explains how and why the forest definition used in the reference level was chosen.**
ART-TREES	The forest definition or definitions listed in the TREES registration document must be **consistent with the most recent definition** used by the national government **in reporting to the UNFCCC**. The same forest definition must be used for each full TREES crediting period. The analyses must be **in accordance with forest definition thresholds** applied by the participant.
VCS-JNR	The definition of forest used in the construction of the reference level **shall be specified** and **shall be consistent with the forest definition used for reporting under the UNFCCC**. Where there is a difference between the most recent definition of forest used in UNFCCC reporting and the definition of forest used in the construction of the reference level, the jurisdictional proponent shall explain how and why the current forest definition was chosen.

The **threshold parametres** for the REDD+ forest definition used by countries submitting a reference level to the UNFCCC (n=56), the FCPF CF (n=15), and ART-TREES (n=1) vary widely. The forest cover thresholds used range from 5–60 percent, tree height thresholds range from 2–7 m, and minimum area thresholds range from 0.1–6.25 ha. Some countries also included a reference to the predominant use of the land, excluding tree crops such as oil palm, for example. The extremes of these ranges are usually used by countries with particular national circumstances. **The most common thresholds are 10 percent and 30 percent for canopy cover, 5 m for height, and 0.5 ha and 1 ha for minimum area**. Twelve countries (21 percent) used FAO's three global forest resources assessment (FRA) thresholds: a canopy cover of 10 percent; a tree height of 5 m; and a minimum area of 0.5 ha. Some countries applied multiple height and canopy cover thresholds with the lower values applicable to dry conditions in the country, or a lower height threshold for mangroves (e.g. Bangladesh and Honduras).

As explained in FAO (2019, 2020) some countries diverged from the forest definition they adopted for REDD+ and used an **operational forest definition**, mostly due to technical limitations with their MRV. ART-TREES requires countries to use the thresholds in the forest definition in their AD assessment.

5.1.2 Scale

	Reporting modalities
UNFCCC	Allows subnational reference levels as an interim measure (Dec.1/CP16p71b), while monitoring and reporting displacement occurs at the national level.
	RBP requirements
GCF pilot phase scorecard	Should be of significant scale – **one political or ecosystem level down from national scale** and defined by each country. Subnational level proposals should demonstrate ambition to scale up to national level and should **demonstrate a contribution to national ambition** for ERs (e.g. the NDC and/or the implementation of the national REDD+ strategy). No deadline for subnational submissions to move to national (the programme has a limited duration).
FCPF MF	Covers a **significant portion of the territory** and aligns with **one or more jurisdictions, or national-government-designated area(s)** (e.g. ecoregion). No deadline for subnational submissions to move to national (the programme has a limited duration).
ART-TREES	Allows **subnational until 2030**. **National scale** accounting is defined as **including ≥ 90 percent of all forest areas** in the country. Areas excluded must be justified (i.e. they are isolated, patchy and historically not subject to deforestation rates of less than half of the national rate); otherwise, 100 percent of forest areas must be included. Boundaries of subnational accounting correspond with the entire area of one or several **jurisdictions no more than one administrative level down from national level** and/or one or more **recognized indigenous territories**. The total subnational accounting area must comprise **at least 2.5 million hectares of forest**.
VCS-JNR	Must correspond to **administrative boundaries no more than two levels down from the national scale**. Jurisdictional proponents shall not exclude boundary areas from the programme within the administrative boundaries of subnational jurisdictional programmes **where GHG emissions from deforestation or forest degradation may be reasonably expected to increase** with respect to the historical reference period during the validity period. No deadline for subnational submissions to move to national.

To the UNFCCC, most countries submit a reference level that is of **national scale** (see Figure 6). Two countries (Colombia and Nigeria) first submitted a subnational reference level followed by a national reference level. Of the eight countries with a subnational reference level, four are from Africa and four are from Latin America and the Caribbean. There are no subnational reference level submissions to the UNFCCC from the Asia-Pacific region.

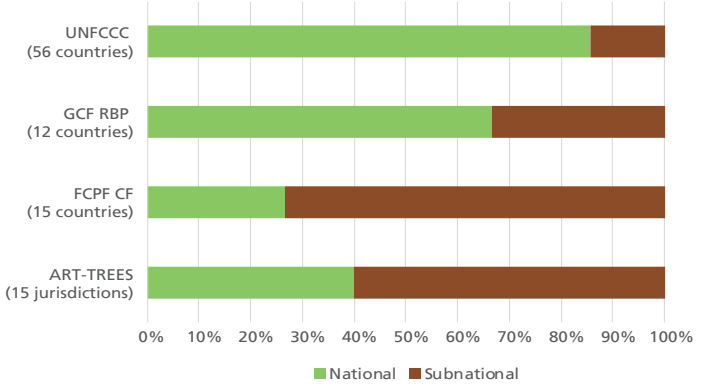


Figure 6. Scale of reference level submissions

Source: Authors' own elaboration

The higher share of subnational reporting in the GCF RBP pilot programme, FCPF CF, and ART-TREES could be an indication that initial REDD+ results may be achieved more quickly at the subnational level and/or REDD+ MRV may be faster at the subnational level. Subnational submissions may be required to provide additional information on potential displacements.

5.1.3 Scope of REDD+ activities

	Reporting modalities
UNFCCC	May include all **REDD+ activities**. Should not exclude significant REDD+ activities; omissions must be justified.
	RBP requirements
GCF pilot phase scorecard	**Same scope as UNFCCC** results submission. Scorecard **may result in a fail if insufficient justification for omission** of a significant activity is provided.
FCPF MF	**All REDD+ activities are eligible**. Deforestation must be included. Forest degradation can be omitted if it represents **< 10 percent of total emissions.**
ART-TREES	All REDD+ activities **except removals from forests remaining forest** are eligible. **Emissions from degradation** can be excluded if exclusion is conservative or where emissions total **<10 percent of deforestation emissions**. Crediting for removals from establishment of new forest is only eligible if emissions are reduced.
VCS-JNR	**Only reduced emissions from deforestation and forest degradation** are eligible. Deforestation cannot be omitted; forest degradation can be omitted if it represents **<5 percent of total emissions.**

Countries define REDD+ activities differently, most notably "plus" activities. To facilitate comparison among countries, Table 5 translates different forest carbon fluxes into the most common REDD+ activity by which countries label these fluxes.

TABLE 5.
Forest carbon fluxes and associated REDD+ activities

Forest carbon flux	Most common REDD+ activity	REDD+
Emissions from forest converted to non-forest land uses (F > NF)	**Deforestation**	REDD
Emissions from forest land remaining as forest land (F > F)	**Degradation** (less frequent: sustainable management of forest)	
Removals from conversion of non-forest land uses to forest (NF > F)	**Enhancement of forest carbon stocks** (less frequent: sustainable management of forest, conservation of forest carbon stocks)	Plus
Removals from forest land remaining as forest land (F > F)	**Enhancement of forest carbon stocks, sustainable management of forest, conservation of forest carbon stocks** (less frequent: degradation)	

In some instances, **REDD+ activities do not correspond perfectly to one of the carbon fluxes,** but are more blurred (see Table 5). One example is where countries define REDD+ activities associated with a certain management type of an area, mixing different forest carbon fluxes occurring (e.g. some

countries, such as Bhutan and Chile, will assess all four carbon fluxes occurring in protected areas and label the net of these fluxes "conservation of forest carbon stocks").

Similarly, the **forest land remaining forest land flux** is not always neatly divided between "REDD" and "plus". Some countries may report on the net flux in forest land remaining forest land, which can be a mix of removals in undisturbed and/or degraded forest (where degradation occurred before the reference period) and net emissions from forest degradation (which may consider post-disturbance removals). Instead, others distinguish between forests where net emissions occur and forests where net removals occur, reporting these separately or only including one of the fluxes in reporting.

The fact that REDD+ activities do not always translate perfectly into the carbon fluxes in Table 5 means that there can be **differences between REDD+ and GHG inventory reporting**, even when the source of data used for both was the same. This is further discussed in FAO (2018a, Box 3).

Figure 7 shows the REDD+ activities (divided under carbon fluxes in Table 5) included in REDD+ reporting under the UNFCCC, GCF RBPs, and the FCPF CF.

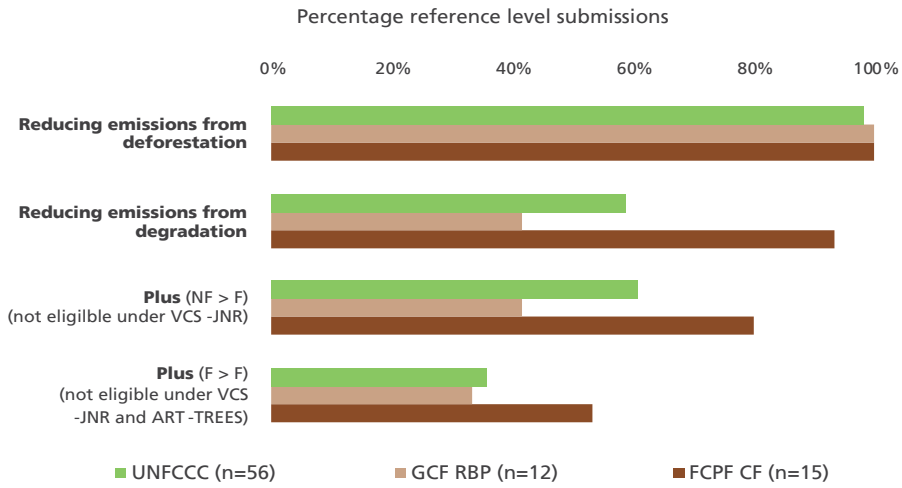


Figure 7. REDD+ activities included in reference levels under the UNFCCC, the GCF RBP pilot programme, and the FCPF CF

Source: Authors' own elaboration

Note: "Plus" activities are combined and re-labelled as either removals from non-forest to forest land or removals from forest land remaining forest land.

The only **country omitting** the **deforestation** flux in REDD+ reporting is Dominica,[9] due to its particular national circumstances, where 85–95 percent of its forest cover was lost in 2017 due to a hurricane. The high inclusion of

[9] India does not include the REDD+ activity, "reducing emissions from deforestation", in its reference level but all forest carbon fluxes are in theory included under the single activity, "sustainable management of forests". Dominica's technical assessment is still ongoing; the scope may change once finalized.

deforestation compared to the other REDD+ activities for the GCF RBP pilot programme could once more be a reflection of early submissions, where countries more frequently included only deforestation. The relatively high inclusion of **forest degradation** under the FCPF CF can be explained, since this programme does not allow for the omission of this activity unless it accounts for <10 percent of total emissions. Only 9 percent of UNFCCC reference levels include the activity – emissions of forest degradation were less than 10 percent of total emissions. Most countries exclude degradation from their UNFCCC submissions due to the lack of reliable data on the activity.

Figure 7 shows that the least included flux in REDD+ reporting concerns **"plus" activities (forest remaining forest)**. Challenges with the methodologies to assess removals in forest land remaining forest land is further discussed in section 5.1.6 and additional challenges with this flux are discussed in Section 6.3. This flux is not eligible under ART-TREES and VCS-JNR. Both Chile and Costa Rica's REDD+ results rewarded with RBPs from the GCF include removals from forest land remaining forest land.

There are several **challenges associated with removals from conversion to forest land** against a reference level, mainly – but not only – related to the delayed removals resulting from growth. These challenges are explained in more detail in Lee, Skutsch and Sandker (2018). The FCPF guidance note on legacy emissions and removals (FCPF, 2021b) provides a methodology for accounting of ERs from activities with legacy emissions/removals in a way that seeks to avoid underestimations and overestimations of ERs due to legacy effects.

5.1.4 Scope of carbon pools and gases

	Reporting modalities
UNFCCC	May include all **pools and gases**. Should **not exclude significant pools**; omissions must be justified.
	RBP requirements
GCF pilot phase scorecard	**Same scope as UNFCCC** results submission. If omission of a significant pool or gas is not well justified, this will result in a lower score on the scorecard (no fail).
FCPF MF	Carbon pools and gases can be omitted if their **omission is conservative** or emissions associated with **excluded pools and gases collectively amount to less than 10 percent** of total emissions.
ART-TREES	Must include: above-ground biomass (**AGB**) and **soil organic carbon** (peatland). Must include: CO_2 Other carbon pools can be omitted if their **omission is conservative** or if it amounts to **less than 3 percent** of total emissions (and the **sum of emissions from excluded pools and gases does not exceed 10 percent** of emissions). Requirements on how to assess pools are included in section 5.1.6
VCS-JNR	Must **include: AGB** and below-ground biomass (**BGB**). Must **exclude: soil organic carbon**. Other carbon pools can be omitted if their **omission is conservative** or if they collectively amount to **less than 10 percent** of the total emissions. Requirements on how to assess pools are included in section 5.1.6

Concerning the scope of carbon pools, **AGB** is included in all reference levels to the UNFCCC, the GCF RBP pilot programme, and the FCPF CF (see Figure 8). **BGB** is included for all UNFCCC and FCPF CF reference levels. One country (Indonesia) omitted BGB in its initial reference level to the UNFCCC, which formed the basis of the GCF RBP pilot programme.

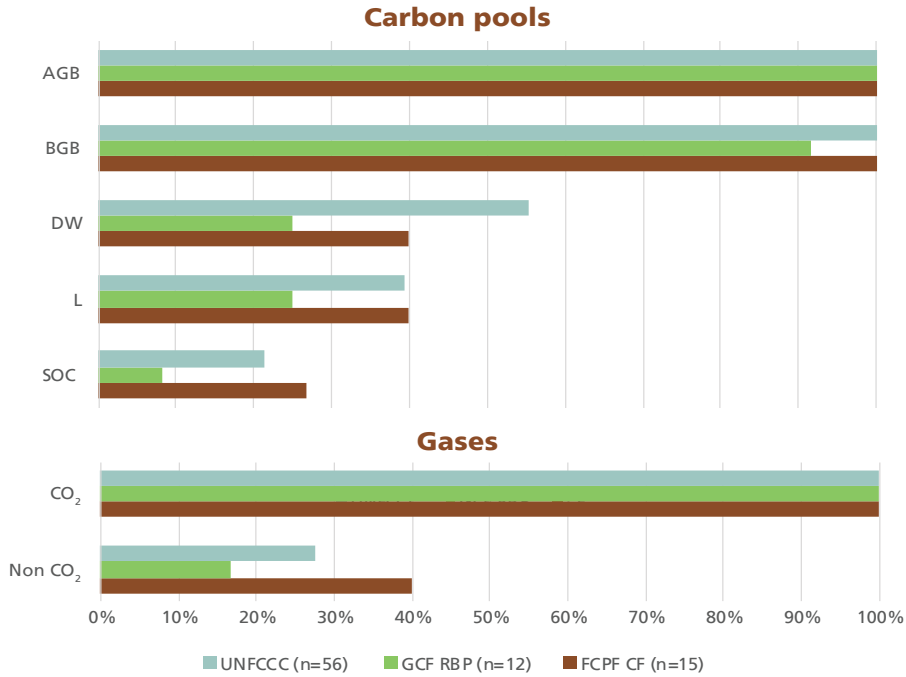


Figure 8. Scope of carbon pools and gases chosen by countries for their reference level under the UNFCCC, the GCF RBP pilot programme, and the FCPF CF

Source: Authors' own elaboration

Note: For some REDD+ activities, the scope covers less pools (e.g. in some cases, BGB is considered for deforestation but not for enhancement of forest carbon stocks).

Dead wood (DW) was included mainly by countries that assessed this pool in their NFI. The *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* provides default values for DW, as opposed to the IPCC 2006 guidelines, which indicated that there was too little coherence in the literature to propose a single value per climate type.

Litter (L) was also included mainly by countries that assessed this pool in their NFI (often only measured in a subset of plots). Other countries that did include L used IPCC default values.

Soil remains the least-included pool in reference level submissions. Estimating emissions from the soil carbon pool is challenging for multiple reasons. First, IPCC suggests the use of a 20-year default transition period, which creates significant lagged emissions that build up over time and are not

balanced if countries are only able to start including these from the beginning of the reference period (requiring data from before the start of the reference period). Second, a Tier 1[10] assessment of soil emissions requires detailed knowledge of the land use replacing forest after deforestation, including inputs and management regimes of this non-forest land use. FCPF (2021) provides a methodology for accounting emissions from the soil pool that avoids lagged emissions to interfere with the results assessment.

All submissions include **CO_2** and 17–40 percent of the submissions (UNFCCC, GCF RBP and FCPF CF) include **non-CO_2** emissions, mostly from fire but some from drainage of peatland (e.g. Indonesia).

5.1.5 Methodologies for assessing activity data

	Reporting modalities
UNFCCC	**No specific requirement on AD**, but generic modalities on data and information apply as follows: The information provided should be guided by the most recent **IPCC** guidance and guidelines, as adopted or encouraged by the COP, and should be **transparent, complete** (i.e. allowing reconstruction), **consistent**, and **accurate** (UNFCCC Decision 12/CP.17).
	RBP requirements
GCF pilot phase scorecard	The scorecard assesses the fulfilment of the COP decision requirements (see UNFCCC modalities above). The degree to which these are met determine the scorecard score. If any of the above is not met, **this could result in a fail**.
FCPF MF	Deforestation is determined using **IPCC Approach 3**. Other sinks and sources such as degradation may be determined using **indirect methods** such as survey data, proxies derived from landscape ecology, or statistical data on timber harvesting and regrowth (if no direct methods are available). AD method needs to allow **quantification of uncertainty**.
ART-TREES	AD is derived from **remote sensing data** or from **verifiable ground-derived data**. Remote sensing data must be **sample-based** or can be a **pixel count in case this is statistically not different** from the sample-based estimate (i.e. it is within the confidence interval around the stratified area estimate). **More than one interpreter must analyse the reference data and/or trained algorithms** and majority agreement must be used for the final reported data. The analyses must be **in accordance with forest definition thresholds** applied by the participant. Where AD comes from **ground-derived data** (e.g. harvested volumes), a quantified estimate of uncertainty must be derived and reported.
VCS-JNR	AD is derived from **remote-sensing data** only. AD represents estimates of land-use transitions over time in ha/year (e.g. forest to non-forest or forest to degraded forest). Area measurements shall be **sample-based** (i.e. when using maps, the stratified area estimate needs to be used in reporting). Reference data shall use high-resolution imagery with a **maximum pixel size of 5 metres per pixel**. Such **high-resolution imagery shall be available for most of the historical reference period** and for **the entirety of the validity period**. Lower resolutions imagery may only be used if high-resolution imagery is not available.

[10] A tier represents a level of methodological complexity. Usually three tiers are provided. Tier 1 is the basic method, Tier 2 is intermediate, and Tier 3 is the most demanding in terms of complexity and data requirements.

To assess emissions from deforestation, countries used either area estimates from wall-to-wall change maps (referred to as **pixel counts**) or area estimates from **sample-based** assessments. Sample-based estimates can be stratified using wall-to-wall maps including deforestation in the map (referred to as **stratified area estimate** and described by Olofsson *et al.*, 2014) or from samples only with either a systematic or random distribution and sometimes using a map for intensification (e.g. using a forest/non-forest map, but not using a map with deforestation as the stratified area estimate). Many countries reporting pixel counts have done an accuracy assessment following the steps outlined by Olofsson *et al.* (2014) but do not report the stratified area estimates. These methods and their differences are explained in detail in FAO (2018a) and some lessons learned from stratified area estimates are provided in GFOI (2018) and FAO (2019).

Figure 9 shows that 70 and 87 percent of countries reporting to the UNFCCC and FCPF CF, respectively, use **sample-based approaches for estimating deforestation areas.** The high percentage of pixel counts in previous periods in countries receiving GCF RBPs may reflect early methods used by countries as pixel-counting dominated REDD+ reporting to the UNFCCC in the early days. Over time, countries shifted towards sample-based reporting. For example, five countries (Cambodia, Ghana, Madagascar, Mexico and Peru) used pixel counts in their first reference level submission to the UNFCCC, replacing this with sample-based estimates in their most recent reference level submission. The high share of sample-based estimates for deforestation areas under the FCPF CF is likely associated with the requirement that uncertainty needs to be quantified. Pixel counts neither correct for systematic error nor allow for the calculation of confidence intervals around the area estimate (Olofsson *et al.*, 2014; GFOI, 2016). As such, 13 percent pixel counts under the FCPF CF submissions may decline further as countries make technical

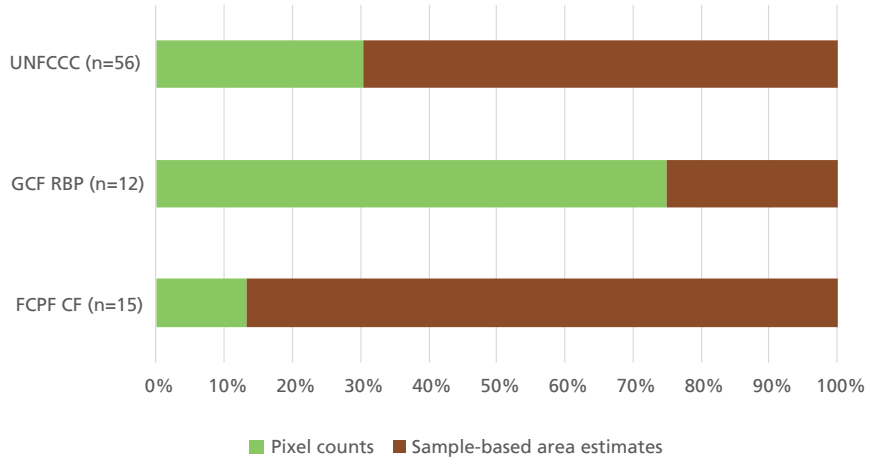


Figure 9. Methods used to assess deforestation areas
Source: Authors' own elaboration

improvements and/or corrections when submitting their ER monitoring report. For example, Indonesia replaced its pixel count AD estimate in the ERPD with a sample-based area estimate in the monitoring report. The expected uncertainties in deforestation area estimates vary with forest type (e.g. dry versus humid) and deforestation type (e.g. scattered versus large-scale). The importance of high-quality data in estimating deforestation emissions and ERs is discussed in Sandker *et al.* (2021).

For assessing AD for forest degradation, a variety of methods are proposed, the most common of which are presented in Figure 10. **Remote sensing-based assessments of degradation areas (sample-based or pixel counts) are most frequently used by countries**. The limited use of ground measurements could be explained by its limited availability and high cost in many countries. Timber statistics can only be used if the data is good quality and comparable over time, if extracted volume can reliably be converted into approximate emissions (e.g. this may be challenging for timber sourced partially from timber plantations and partially from logging concessions), and if it forms a representative proxy of degradation in the country (e.g. if degradation is not mostly from timber extraction, the estimate may be highly inaccurate if sourced on timber statistics).

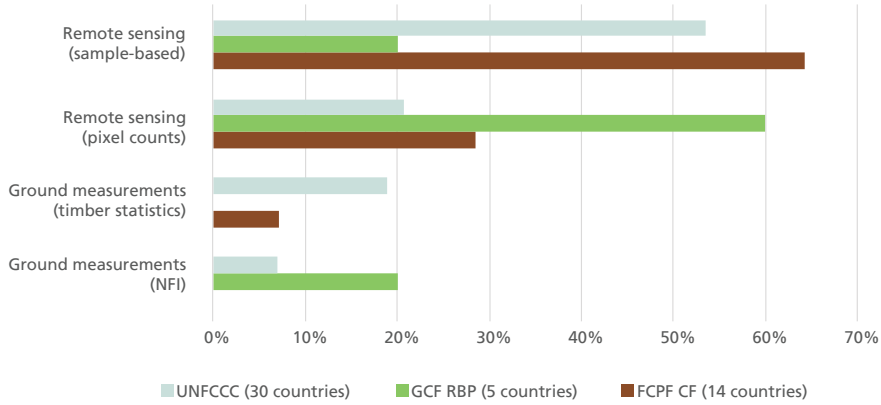


Figure 10. The most common methodologies for assessing forest degradation activity data in reference levels under the UNFCCC, the GCF RBP pilot programme, and the FCPF CF

Source: Authors' own elaboration

Note: The number of countries is lower since not all countries included degradation in the scope of their reference level.

5.1.6 Methodologies for assessing emission and removal factors

	Reporting modalities
UNFCCC	**EFs**. Generic modalities on data and information same as those listed under AD.
	RBP requirements
GCF pilot phase scorecard	No specific criteria related to EFs in the scorecard.
FCPF MF	**IPCC Tier 2** or higher methods are used to establish EFs, and the uncertainty for each EF is documented. IPCC Tier 1 methods may be considered in exceptional cases.
ART-TREES	Must use **net EFs** (i.e. EF need to consider the carbon contents in the replacing land use). **Post-disturbance removals** can be **instantaneous or annualized** and must be annualized if the GHG inventory uses annualized post-disturbance carbon stock changes. Post-disturbance carbon stock must be a **long-term average**. All emissions **can be taken immediately** at the time of the AD for the purpose of simplified accounting, **except for emissions from peat soils**. **AGB** and **soil organic matter (peat soils)** must result from IPCC **Tier 2** or **Tier 3** methods. Secondary pools (BGB, DW, L, and soil organic matter [mineral soils] may be calculated using literature or IPCC **Tier 1**. Removal factors can be derived from several data sources, including Tier 1. IPCC Tier 1 default factors may be used in all instances for removals but **must be shown to be conservative** through **on-the-ground measurements or country-specific peer-reviewed literature**.
VCS-JNR	Must use **net EFs** (i.e. EF need to consider the carbon contents in the replacing land use). **Post-disturbance removals** must be **instantaneous**, where post-disturbance carbon stock must be a **long-term average**. EFs shall be calculated as the difference in carbon stocks due to land-use transitions, expressed in tCO_2/ha. **AGB** and **BGB** shall be estimated **using a plot-based field inventory** conducted within the jurisdictional area. Where only few sample units of NFIs fall into the jurisdictional area, sample units from other areas can be used, if these can be shown to be representative of the forest within the jurisdictional area. DW and L shall be estimated through **field inventories** conducted within the jurisdictional area. **Default data** for DW and L can only be used if they are collectively expected to amount to **less than 15 percent** of the total carbon stocks. Plot-based field inventories shall comply with several requirements, including that raw measurements shall be available, a minimum of 20 sample units shall be used in each forest type, and when compiled from different sources, a demonstration that the estimate is representative of the jurisdiction.

For **deforestation**, countries mainly used **inventory data to estimate the associated EF**, either from the NFI, from the ongoing NFI's preliminary values, or from local inventories. Countries have made significant progress in collecting information on their forest resources over time. Nesha *et al.* (2021) found that the number of countries with good to very good NFI capacities increased from 48 in 2005 to 102 in 2020. Figure 11 shows that 91 percent of the 56 countries reporting REDD+ reference levels under the UNFCCC have an NFI. This suggests that the data that countries use for estimating the forest carbon stock is relatively high in quality. However, **roughly two out of three countries submitting a reference level to the UNFCCC do not consider the carbon stock in post-deforestation land-use** in their EF calculation, which may result in an overestimation of emissions from deforestation.

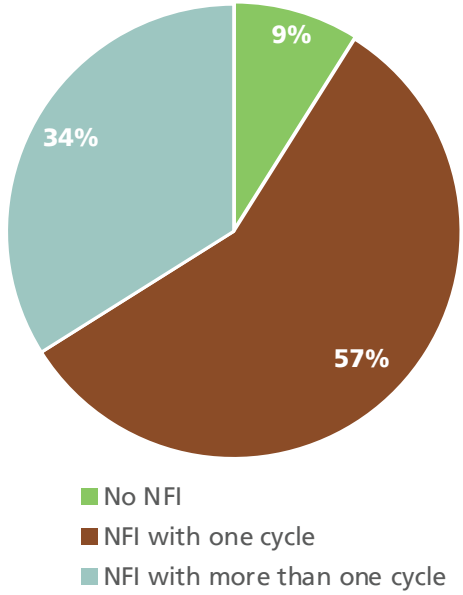


Figure 11. Percentage of countries reporting a REDD+ reference level to the UNFCCC (n=56) with a national forest inventory with one or multiple cycles
Source: Authors' own elaboration

EFs associated with **forest degradation** are **not as frequently derived from data collected through the NFI** as deforestation EFs. Where the degradation EF is derived from the NFI, countries frequently assess this as either: i) the difference in average carbon stock of intact and degraded/disturbed forest; ii) assessing the relative canopy cover reduction in the AD and applying this percentage to the average carbon stock to approximate the degradation EF; or iii) assessing the relative canopy cover reduction in the AD while establishing a regression between canopy cover and biomass from NFI plots to approximate the expected biomass loss from average canopy cover reduction. Only two countries (Thailand and Viet Nam) use multiple NFI cycles to assess emissions from degradation. Countries using timber statistics as AD tend to estimate emissions per cubic meter, usually derived from local field measurements in timber concessions.

As illustrated in Figure 7, **removals in forest land remaining forest land** is the least reported forest carbon flux. Since the biomass increase in forest land remaining forest land is typically a slow and gradual process, it cannot be accurately assessed through remote sensing. Permanent sample plots (PSPs) seem promising for assessing these gradual changes over time. Even though **19 of REDD+ reporting countries (34 percent) have multiple NFI cycles**, very few of these actually contain PSPs, and **only three countries (5 percent) use repeated NFI cycles** for (part of) their REDD+ reporting.

Even when PSPs are available to the country, this still leaves the challenge of extrapolating the information from these point measurements to the large area of forest land remaining forest land. The assessment of net growth is further complicated through natural dynamics with mortality and growth happening simultaneously, not to mention the impact climate change may have on this flux. Establishing and maintaining PSPs within NFIs is challenging because they are more expensive to establish and measure than temporary sample plots; in order to be efficient, they require a stabilized inventory design and preferably a constant remeasurement interval. One potential solution is testing and further developing spatially balanced sampling methods where different plot types are combined (permanent, semi-permanent and temporary) (see Köhl *et al.*, 2015; Grafström *et al.*, 2017; Räty and Kangas, 2019). Grassi *et al.* (2022) further discuss challenges in assessing the carbon flux from forest land remaining forest land, where major discrepancies can originate from different methodologies to assess this flux.

Removal factors associated with forest expansion are also rarely obtained from NFIs. Challenges typically include a lack of representative age class measurements to create a growth curve with associated increment factors.

5.1.7 Reference and validity periods

In this publication, a reference period is the historical period of emissions considered to establish the reference level; a validity period is the period over which the reference level is used to assess ERs.

	Reporting modalities
UNFCCC	No guidance on reference period or gap between reference and reporting period. No specific guidance on validity period but reference level should be updated periodically (Dec12/CP17/Add.2p12).
	RBP requirements
GCF pilot phase scorecard	**Reference period: 5-20 years** (otherwise fail). Highest score 10–15 years. **Validity period: No requirements**, programme has limited duration. **Gap** between reference and validity period; highest score with gap is **<6 years – no fail.**
FCPF MF	**Reference period: 10–15 years** (typically 10 years; with justification, up to 15 years). **Validity period: No requirements**; pilot does not foresee updating of reference level. **Gap** between reference and validity period: **allowed and common**.
ART-TREES	**Reference period: 5 years**. **Validity period: 5 years**. **Gap** between reference and validity period: **not allowed**.
VCS-JNR	**Reference period: 4 to 6 years** (longer periods allowed if more conservative). **Validity period: 4 to 6 years**. **Gap** between reference and validity period: **allowed up to 2 years**.

Concerning the **length of the reference period**, UNFCCC modalities provide no guidance on the period to consider. Standards or programmes for RBPs, on the contrary, do provide quite specific requirements where we appear to have seen a change over time **towards a preference for a shorter reference period**. The FCPF MF (2016, 2020) and GCF RBP scorecard (2017) require or prefer a period of 10 to 15 years. Instead, more recent guidance from ART-TREES (2021) and VCS-JNR (Verra, 2021a) requires a much shorter period of five and four to six years, respectively. Figure 12 shows that reference periods of 10 to 15 years are the most common for UNFCCC, GCF RBP pilot programme, and the FCPF CF.

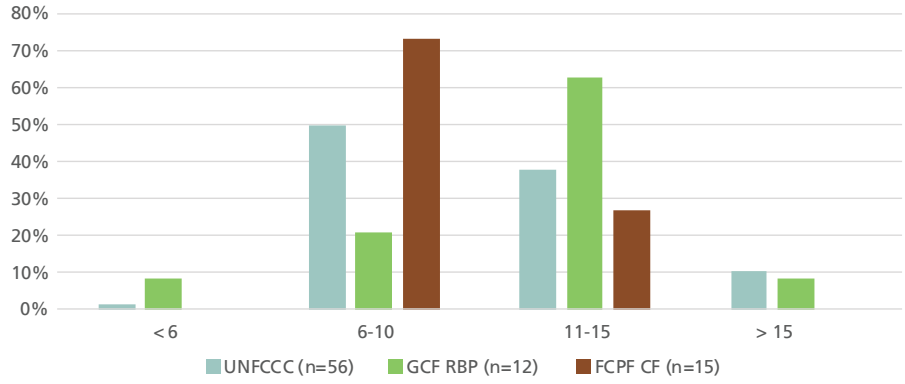


Figure 12. Length of reference period in submissions to the UNFCCC, the GCF RBP pilot programme, and the FCPF CF
Source: Authors' own elaboration

As the UNFCCC modalities do not provide specific guidance on the reference level validity period, roughly two out of three reference level submissions **do not explicitly mention the validity period**. For those submissions that do define a validity period of their reference level, this ranges between 4 years (Solomon Islands) and 15 years (Costa Rica's reference level II and Panama's first reference level submission). Around 60 percent of countries defining a validity period suggest this to be five years. For the countries that submitted a concept note to the **GCF RBP pilot programme, we see the opposite, with the majority of submissions (67 percent) defining a validity period**. Looking at the FCPF CF submissions, the countries do not seem to define a validity period, but a very precise period is included in the ERPAs. The reporting periods defined in the ERPAs vary between three years and nine months to seven years. On average, the reporting period in the ERPA is 5.5 years.

Though the UNFCCC modalities do not provide guidance on gaps between the end of the reference level and beginning of the reporting period, **none of the 18 countries reporting ERs to the UNFCCC left a gap** between the end of the reference period and the first year of ERs reported. Likewise, the

countries participating in the GCF RBP pilot programme are not leaving gaps in reporting, but given that the pilot programme only provides RBPs for the years 2014 to 2018, some countries were offered ERs from 2014 onwards while achieving ERs over earlier years as well. This is different for the FCPF CF, where the reference periods end between 2011 to 2016, while the reporting periods in the ERPA start between 2018 and 2021. On average, there is a **gap of just over four years** between the last year of the reference period and the start of the reporting period in the ERPA.

5.1.8 Construction approaches and adjustments

	Reporting modalities
UNFCCC	No specific requirement or limitations to adjustments. General guidance as follows: Countries establishing reference levels should take into account historical data and adjust for national circumstances (Decision 4/CP.15, 2009).
	RBP requirements
GCF pilot phase scorecard	Reference level must be equal to or below **historical average unless country is HFLD**. If HFLD, the **adjustment may not exceed 0.02 percent of carbon stock and 10 percent of the reference level**.
FCPF MF	Reference level must be equal to or below the **historical average, unless country is HFLD**. If HFLD, the **adjustment may not exceed 0.1 percent of carbon stock**.
ART-TREES	Reference level must be equal to or below **historical average, unless jurisdiction is HFLD**. To qualify as HFLD, the jurisdiction **must reach a minimum HFLD score of 0.5** (HFLD score is calculated based on forest cover and deforestation rate). If the jurisdiction meets the threshold for each year of the reference period, its crediting level is the historical average plus the **HFLD score (<1) multiplied by 0.05 percent of the carbon stock**. HFLD jurisdictions may account for foregone removals.
VCS-JNR	Reference level **must be equal to or below historical average**. No adjustment or trend extrapolation allowed for HFLD countries

Figure 13 shows that a large majority (80 percent) of countries propose a historical average (or below historical average) to establish their reference level to the UNFCCC. Countries expecting future forest emissions to be higher than emissions assessed over the reference period propose either a linear trend extrapolation or an upward adjustment. Most of these are HFLD countries.

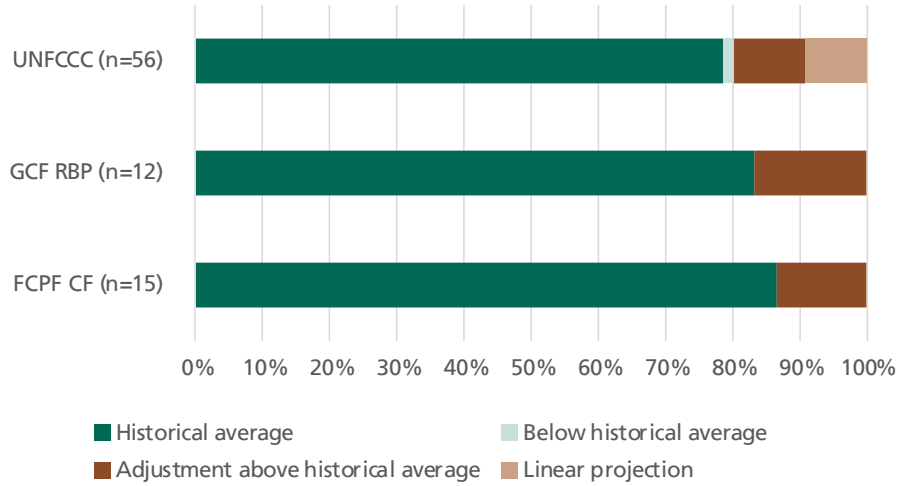


Figure 13. Construction approach used for reference levels under the UNFCCC, the GCF RBP pilot programme, and the FCPF CF

Source: Authors' own elaboration

Note: Adjustment above historical average concerns an upwards adjustment of emissions and in one case (Viet Nam) an upwards adjustment of removals (i.e. a less negative value). Below historical average is proposed by Dominica, where due to a hurricane, 85–95 percent of forest cover was lost in 2017.

5.2. SUMMARY OF SUBMITTED REDD+ RESULTS

5.2.1 REDD+ results reported

As of September 2022, the **UNFCCC** had received **27 REDD+ results submissions from 18 countries**. The results reported a total of **11.49** billion tCO_2 **of ERs** achieved between 2006 and 2020. Around 50 percent of these ERs (5.6 billion tCO_2) were achieved before 2014 (see Figure 14). The majority of the 11.49 billion tCO_2 ERs (9.4 billion tCO_2 or 82 percent of the total ERs) were from one country (Brazil). Some imbalance is seen in results reporting per continent, where 86 percent of all ERs reported are from Latin America (10 countries), 13 percent are from Asia and the Pacific (6 countries) and 1.7 percent are from Africa (2 countries).

Annual average cumulative results reported over the 2006–2020 period are 770 million tCO_2/yr, but considering the time countries need for MRV, more results may still be reported, especially for recent years. Average annual ER volumes reported by individual countries vary largely with the smallest annual average of Honduras (2017–2018) being 0.9 million tCO_2/year and the largest annual average of Brazil Amazon (2011–2015) being 631 million tCO_2/year, which is a factor 715 difference.

The ERs reported by the 12 countries that **submitted a concept note to the GCF RBP pilot programme** add up to 4.5 billion tCO_2eq for the period 2014–2018. The eight proposals that received RBPs corresponded to **different shares of the ERs countries reported to the UNFCCC** for the years within the

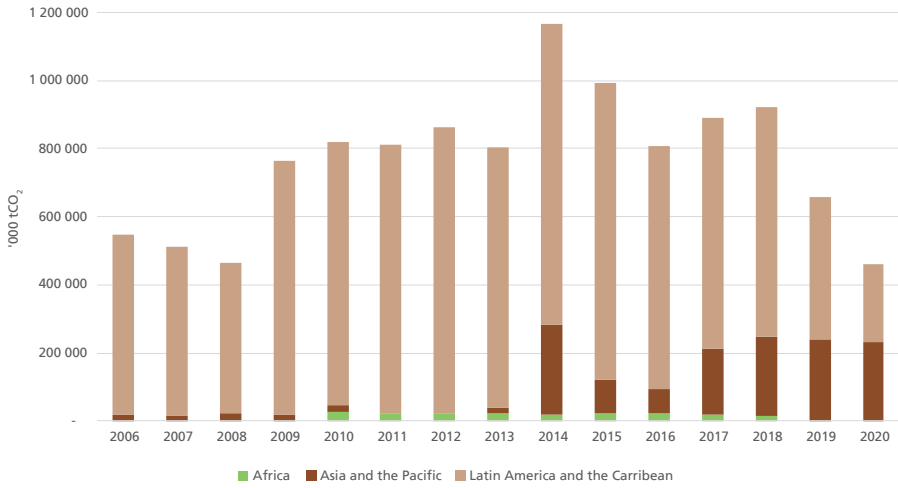


Figure 14. Cumulative annual REDD+ results reported to the UNFCCC by region
Source: Authors' own elaboration

RBP programme. These shares ranged from **2 percent (Brazil) to 100 percent (Ecuador)** of the ERs reported to the UNFCCC. Under the pilot phase, a maximum payment per country was set to 30 percent of the size of the total envelope of the programme. The **eight countries that received RBPs** from the GCF offered **133 million tCO_2eq** to the RBP pilot programme (this amount does not consider the buffers some countries included). The ERs reported to the UNFCCC by the **four countries that submitted a concept note**, after the RBP pilot programme's envelope was depleted, were a total of **377 million tCO_2eq.**[11] As discussed in Section 2.2, it is unclear if (a share of) these ERs will be awarded RBPs by the GCF.

The total ERs reported to the **FCPF CF** between 2016 and 2021 by **Costa Rica, Ghana, Indonesia, Mozambique** and **Viet Nam**[12] add up to **104 million tCO_2**. This is more than the FCPF ERs (the creditable ERs for RBPs under the ERPA), since the results under the monitoring period sometimes exceed the results under the reporting period,[13] and since the FCPF ERs apply deductions to the achieved ERs (see Section 2.1 and Section 4.1).

[11] This is 70 million tCO_2eq, 284 million tCO_2eq, 15 million tCO_2eq and 8 million tCO_2eq for Papua New Guinea, Viet Nam, the Lao People's Democratic Republic, and Uganda, respectively. Both Papua New Guinea and Viet Nam proposed adjustments for national circumstances. Limiting or removing these adjustments in line with the pilot phase second stage scorecard, the REDD+ results from Papua New Guinea and Viet Nam would be 6.6 million tCO_2eq (instead of 9 million tCO_2eq in BUR1) and 243 million tCO_2eq, respectively (GCF 2019a, 2020b), or 27 percent and 14 percent lower than the UNFCCC reported results.

[12] The validation and verification of Indonesia's and Viet Nam's monitoring reports and Mozambique's second monitoring report (with results for 2019 and 2020, respectively) are still ongoing; the reported ERs may change.

[13] The monitoring period has to be multiple of one year, while the reporting period is sometimes a fraction of a year (e.g. when the ERPA defines the start of the reporting period as the date of ERPA signature).

The total ERs reported to **ART-TREES** by **Guyana**[14] add up to **41.6 million tCO_2 (under validation and verification)** between 2016 and 2020. This is more than the TREES ERs (creditable ERs for the voluntary carbon market), since TREES applies a deduction to the achieved ERs (see Section 2.1 and Section 4.3).

The combined REDD+ results reported to the FCPF CF and ART-TREES add up to **146 million tCO_2eq**, with 60 percent from the Asia and the Pacific region, 36 percent from Latin America and the Caribbean, and 4 percent from Africa (see Figure 15). The negative REDD+ ERs in 2020 are due to Mozambique, whose second monitoring report contains ERs for 2019 and an emission increase in 2020.

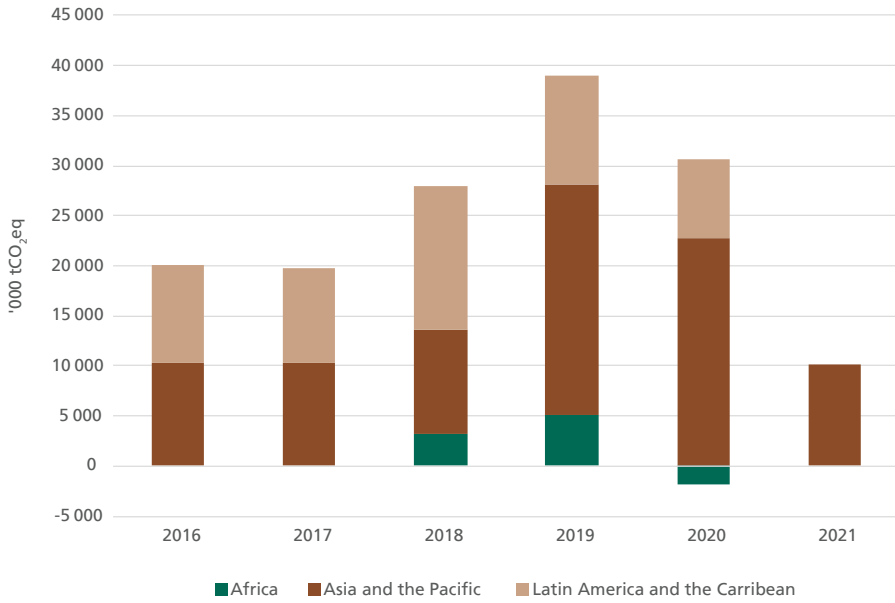


Figure 15. Cumulative annual jurisdictional REDD+ results reported to the FCPF CF and ART-TREES by region

Source: Authors' own elaboration

Note: Indonesia's ERs are from July 2019–June 2021; the amounts have been divided equally over the years (i.e. half of the amount reported for 2019–2020 is shown in the graph in 2019 and half in 2020).

[14] Guyana's validation and verification is still ongoing; the reported ERs may change.

5.2.2 Results per activity

Approximately[15] **94 percent of the REDD+ results reported to the UNFCCC concern reduced emissions from deforestation**. The approximate share of REDD+ results coming from the **"plus" activities is 4 percent** and the share coming from reducing emissions from **forest degradation is 1.5 percent**. It is worthwhile to consider that many countries have not yet included forest degradation and the "plus" activity in the scope of their reference level and therefore could not report results even if there were any.

For countries that included both deforestation and forest degradation in the scope of their reference level, **historical emissions are on average for 67 percent from deforestation and 33 percent from forest degradation** (based on 25 countries[16]). Yet, considering that forest degradation is often excluded from the scope, the combined reference level values include more historical emissions from deforestation. It is difficult to compare reference level values among countries as they tend to apply to different results reporting periods; they are often different in scope and scale, some are net and others gross, and they are assessed with different methodologies and definitions. Considering these limitations, the combined emissions in all reference levels (considering the net emitting REDD+ activities only) for the 2015–2020 period average is **4.1 billion tCO_2eq/yr** (for 51 countries[17]). Of this 4.1 billion tCO_2eq/yr, 3.7 billion tCO_2 (92 percent) correspond to emissions from deforestation (from 50 countries) and 0.3 billion tCO_2 (8 percent) correspond to emissions from forest degradation (from 26 countries). The combined net removals included in reference level values for "plus" activities (when reported separately) for the 2015–2020 period annual average is **-0.57 billion tCO_2/yr** (for 21 countries). This means the "plus" activities remove on average 0.57 billion tCO_2 from the atmosphere each year. ERs for removals are generally assessed when these average annual removals are exceeded.

Instead, for ERs reported to the **FCPF CF** (five countries), **42 percent concerns reduced emissions from deforestation, 33 percent concerns reduced emissions from forest degradation,** and **25 percent concerns increased removals from "plus" activities**. Looking at historical emissions in the reference levels submitted, for countries that included both deforestation and

[15] The calculations of these percentages are approximate since some countries report combined results for multiple REDD+ activities where the data submitted does not allow disaggregation by activity. However, these REDD+ results from multiple combined activities concern 0.5 percent of the total cumulative ERs. The approximate percentages provided exclude this 0.5 percent.

[16] There are 33 countries including degradation in the scope of their reference level; excluded in the percentage calculation are countries that do not report on emissions per activity or that included degradation only partially.

[17] The five countries not included here either reported a reference level expressed as a net removal where it was not possible to separate out the net emitting activities, or had defined a validity period of the reference level that did not overlap with the 2015–2020 period. Only the values in the most recent reference level submissions are considered.

forest degradation in the scope of their reference level, **historical emissions are on average 66 percent from deforestation and 34 percent from forest degradation** (based on 14 countries), which is similar to this assessment in UNFCCC submissions. The combined emissions in all FCPF CF reference levels considering net emitting activities adds up to **217 million tCO_2eq/yr** (from 15 countries), while combined removals from "plus" activities adds up to **35 million tCO_2eq/yr** (from 12 countries).

5.2.3 Relative reduction compared to reference level

The net annual ERs reported to the UNFCCC for net emitting activities consist of an average **35 percent reduction against reference levels,**[18] meaning emissions over the results period are on average 35 percent lower than emissions in the reference level. Disaggregating by activity (where possible) provides an average 38 percent reduction of emissions from deforestation and an average 31 percent reduction of emissions from forest degradation. The average **increase of removals reported against reference levels is 20 percent** in the UNFCCC reported results. The range of relative ERs per country ranges from -32 to 69 percent. The range of relative removal increases per country is even larger with -83 to 85 percent. The negative values in these ranges mean emissions in the results period were higher than those over the reference period (e.g. Chile) or removals were lower compared to the reference period (e.g. Cambodia).

The net annual ERs reported to the FCPF CF for net emitting activities consist of an average **25 percent reduction against reference levels**. When disaggregating the reductions out by activity, we see an average reduction of 69 percent against historical emissions from deforestation and an average 13 percent increase against historical emissions from forest degradation. Two of the four countries reporting results and including degradation in their scope saw a net increase in degradation emissions over the results period. The average **increase of removals reported against reference levels is 227 percent**. Considering the net of all activities, both Viet Nam and Costa Rica report an approximate 200 percent reduction against the reference level, meaning net emissions over the reference period are converted into net removals over the results period.

Guyana's ER submission to ART-TREES consists of a **38 percent reduction against the reference level**. Since the reference level includes an HFLD adjustment, it is not possible to disaggregate this by activity.

[18] Calculated as the average of annual reductions per country, giving all countries the same weight.

5.2.4 Uncertainty reporting for REDD+ results

Roughly **half (13 of 27) of the REDD+ results submissions include aggregate uncertainties;**[19] however, for 12 of these 13, the reported uncertainties concern the aggregate uncertainty of emissions over the reporting period (and reference period), but not the uncertainties around ERs (which are expected to be larger; see FAO, 2019). Many other submissions do provide details on uncertainties without reporting aggregate uncertainties. Improvements are seen over time, as countries are reporting more information on uncertainties in their BUR technical annexes (e.g. all three REDD+ results submissions in 2022 included aggregate uncertainties); however, **uncertainty reporting remains rather limited** in many submissions and when aggregate uncertainties are provided, they **are frequently calculated incorrectly** (Yanai *et al.*, 2020; FAO, 2020). Yanai *et al.* (2020) finds that uncertainties are commonly underestimated, both by omitting important sources of uncertainty and by incorrectly combining uncertainties. Incorrect uncertainty calculations are typically not commented on during the TA or technical analysis. As described in FAO (2020), the guidelines for the TA and technical analysis put little or no emphasis on uncertainty reporting, and TA and analysis reports often lack a profound assessment of uncertainty calculations, which can be very complicated and require specific skills for its computation and quality control. Furthermore, although the IPCC provides clear guidance on propagating errors for emissions calculations, there is no explicit equation for calculating uncertainties around ERs. Without a correct reporting of uncertainties, **the accuracy of reported ERs cannot be assessed**; therefore, it remains unclear whether the ERs are overestimated or underestimated.

The six REDD+ results submissions to the **FCPF CF all provide uncertainty estimates around ERs** obtained through the Monte Carlo simulation. The **average uncertainty around ERs is 52 percent**[20] with the lowest uncertainty assessed at 11 percent (Indonesia) and the highest at 64 percent (Costa Rica). For Mozambique, the average uncertainty for 2018–2020 is referred to as reported in the second monitoring report. The uncertainty in the first monitoring report is 29 percent, while uncertainty in the second monitoring report is 210 percent. The high uncertainty in the second monitoring report is explained by the ER being relatively small compared to the reference level. FAO (2019) explains how relatively small ERs will have relatively large uncertainties. Uncertainties around the reference level are expected to be lower than uncertainties around ERs. This is illustrated by Ghana who reports an aggregate uncertainty of 23 percent around its reference level and an aggregate uncertainty of 58 percent around its ERs. Five of the

[19] Note that the reporting of aggregate uncertainties is an imperfect indicator of progress because it does not reveal whether all sources of error were included in the calculation. Information on individual error sources would be more useful in the identification of potential areas for improvement (FAO, 2018a).

[20] This is the relative half-width of the 90 percent confidence interval around the median.

six monitoring reports identify uncertainty around AD as the largest source of uncertainty in deforestation emission estimates.

Guyana's REDD+ results submission to **ART-TREES** provides no details on the uncertainty calculation, but based on the reported uncertainty deduction, it appears that the **uncertainty around ERs is 33 percent**. The validation and verification is ongoing and this value may change once finalized.

5.3. FACTORS THAT MAY LIMIT THE VOLUME OF MARKET-BASED CARBON ACCOUNTING

REDD+ results reported to the UNFCCC and in market-based carbon accounting are hard to compare since the context is different, where UNFCCC reporting may have objectives beyond RBPs and market-based reporting is restricted by the additional requirements introduced by the standards. Jurisdictional REDD+ reporting outside the UNFCCC only recently started, with the first submission of REDD+ results to the FCPF CF by Mozambique in 2020 and the first submission of REDD+ results to ART-TREES by Guyana in 2022. Furthermore, as pointed out in Section 5.1 (see Figure 6), UNFCCC submissions are mostly national scale, while market-based jurisdictional REDD+ is mostly subnational scale.

Considering these limitations, one of the most striking differences when comparing UNFCCC REDD+ results and market-based jurisdictional REDD+ results is the **volume, where 11.5 billion tCO_2eq ERs are reported to the UNFCCC and 146 million tCO_2eq ERs are reported to the FCPF CF and ART-TREES combined**. Even when only considering ERs reported over 2016–2020, the UNFCCC reported ERs are still 3.7 billion tCO_2eq, or a factor 26 larger than market-based jurisdictional ERs reported. The volume of ERs reported under market-based jurisdictional REDD+ may still increase over time, but there are some aspects that may limit the volume. The following paragraphs discuss a few factors that may limit the volume under market-based carbon accounting.

One potential limitation to the market-based jurisdictional ER volume is the requirement of the **reference period to be limited to a shorter and more recent historical period**. As Figure 12 in Section 5.2 illustrates, only one of the 56 reference levels submitted to the UNFCCC currently uses a reference period shorter than six years that would meet the ART-TREES and VCS-JNR reference period requirement. To get a sense of the impact this requirement may have on REDD+ reporting, we look at emissions from deforestation and forest degradation in reference level values valid for the period 2015–2020 from the three countries with the highest emissions: Brazil, the Democratic Republic of Congo and Indonesia. The reference level values of these three countries combined adds up to on average 2.8 billion tCO_2eq/yr (68 percent of the total emissions in combined reference level values). These three countries

provide annual emission values in their reference level submissions and using these values to calculate the average emissions over 2010–2015 gives combined emissions of 1.8 billion tCO_2eq/yr, **meaning a five-year historical average reference level gives approximately 1 billion tCO_2eq lower emissions** in the reference level values for these countries and as a consequence, significantly less ERs. Though for some countries a five-year average may actually result in an assessment of larger ERs compared to their UNFCCC reference level, overall the volume is expected to be smaller applying this requirement. It remains unclear in this analysis, which reference period would give a more accurate assessment of achieved ERs as reference levels are counterfactual.

Another important factor that may limit the volume under market-based carbon accounting is the **exclusion of early achieved ERs**. While the earliest ERs covered by an ERPA from the FCPF CF are from 2018 and the earliest possible ERs covered by ART-TREES are from 2016, most will concern a later date.[21] If we only consider ERs from 2018–2020, the reported volume is reduced from 11.5 billion tCO_2eq to 2 billion tCO_2eq. As global deforestation is declining (see Section 6.3), ERs from reduced deforestation are also expected to decline.

Another potentially important difference between UNFCCC reporting and market-based reporting is the methodology used for assessing AD for deforestation and forest degradation. Section 5.1 explained standards preferring or requiring sample-based approaches over pixel counting. Figure 9 in Section 5.1 shows that 68 percent of UNFCCC reference levels used sample-based approaches in their most recent reference level submissions. Though that percentage is very high, the methodologies used for the REDD+ results reported to the UNFCCC are still predominantly based on pixel counting (Figure 16). Figure 16 shows that **only 3 percent of the REDD+ ERs reported to the UNFCCC were assessed with a (partially) sample-based methodology**. Though pixel counts are not necessarily inaccurate, they may result in overestimations or underestimations. Sandker *et al.* (2021) point out that the difference between sample-based estimates and pixel-counting estimates can be very large, showing examples where initial pixel-counting estimates of deforestation areas were corrected downwards by a factor of 3 and 15, respectively, when replaced by sample-based assessments.

[21] The initial crediting period may begin up to four calendar years prior to the year the participant submits the TREES concept.

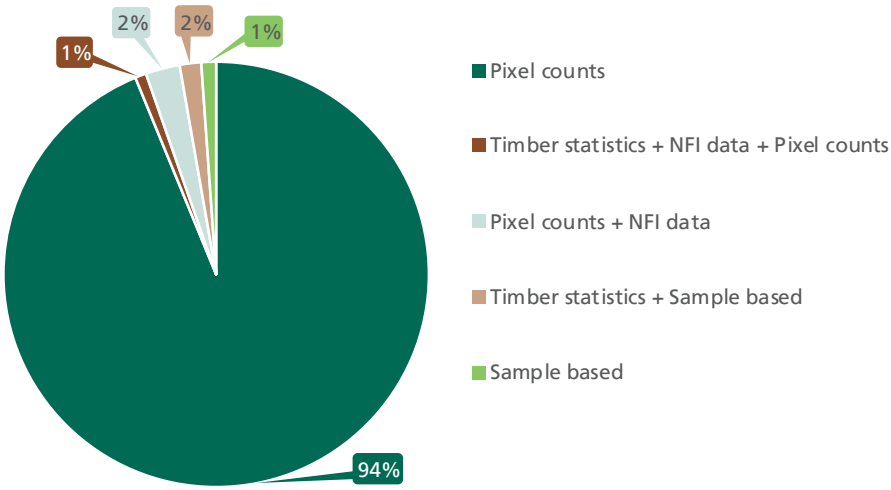


Figure 16. Cumulative REDD+ results reported to the UNFCCC disaggregated by activity data assessment methodology
Source: Authors' own elaboration

6. REDD+ reporting and the Paris Agreement

6.1. ENHANCED TRANSPARENCY FRAMEWORK

Article 13 of the Paris Agreement establishes the ETF for action and support designed to **build trust and confidence that all countries are contributing their share to the global effort**. The ETF is **based on existing transparency arrangements set up under the UNFCCC, commonly known as the MRV framework**. Parties under the ETF are required to submit their first BTR and national inventory report by 31 December 2024. BTRs will be considered at a collective level as an important input into the GST, which aims to assess the world's collective progress towards achieving the purpose of the agreement and its long-term goals (see Section 6.2 and Section 6.3).

In December 2018 (COP 24), Decision 18/CMA.1 adopted the MPGs and in 2021 (COP26), Decision 5/CMA.3 provided the guidance for operationalizing the MPGs. A **set of common formats for reporting the national GHG inventories** are now available: information necessary to track progress made in implementing and achieving NDCs; information on financial, technology development and transfer, and capacity-building support provided and mobilized; and the outlines for the BTR (including technical annexes for REDD+) and national inventory document. The MPGs define the reporting information to be provided, the technical expert review, transitional arrangements, and a facilitative multilateral consideration of progress. The MPGs will supersede the existing MRV requirements under the convention, including:

- Reporting of the biennial report and/or BUR under the convention will be superseded by reporting of the BTR for the Paris Agreement.
- Review of the biennial report and technical analysis of the BUR under the convention will be superseded by **technical expert review** for the Paris Agreement.
- Multilateral assessment and facilitative sharing of views under the convention will be superseded by the **facilitative multilateral consideration of progress** for the Paris Agreement.

The following elements will continue to be reported under the Convention and are not superseded by the MPGs:

- A national communication must continue to be submitted by all countries.
- An annual GHG inventory must continue to be submitted by developed

countries, but following the requirements of the MPGs instead of Decision 24/CP.19.

- The **proposed REDD+ reference level** by developing country parties and subject to a TA.
- The **technical annex on REDD+** to be reported in BURs for those Parties seeking RBPs will be reported as an annex to the BTR and technically analysed during the review of the BTR.

Further information in moving from the MRV to the ETF is available: https://unfccc.int/enhanced-transparency-framework. The UNFCCC's ETF Manual also illustrates how information flows from Parties' NDCs to their BTRs will then serve to the GST (see Figure 17 below).

Under the ETF, accurate forest-related data collection, analysis and

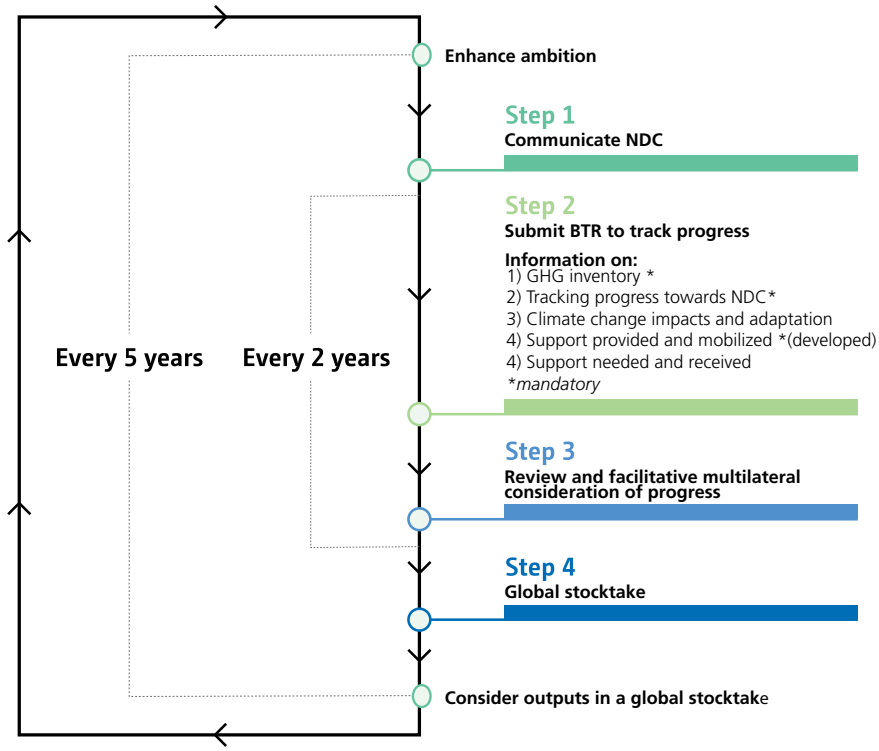


Figure 17. Reporting nationally determined contributions, biennial transparency reports and the Global Stocktake

Source: UNFCCC, 2022

dissemination is at the basis for reporting on emissions and removals, as well as tracking progress in meeting NDCs. Therefore, a robust NFMS will enable countries to respond to national data needs as well as report on their

climate commitments. Six case studies reflecting the importance of NFMS related to REDD+ and transparency are available for: Bangladesh (FAO, 2020a), Chile (FAO, 2021b), Costa Rica (FAO, 2020b), Democratic Republic of the Congo (FAO, 2020c), Ghana (FAO, 2021c), and Papua New Guinea (FAO, 2021d). FAO (2022) provides experiences and lessons learned on forests and transparency under the Paris Agreement.

6.2. REDD+ REPORTING AND NATIONALLY DETERMINED CONTRIBUTIONS

NDCs are high-level political commitments made by countries to undertake transformative low-carbon and climate-resilient action and contribute to the global response to climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive NDCs, in which national efforts communicated must represent a progression over time.

The Paris Agreement recognizes the **crucial role of forests in climate change mitigation and adaptation in Article 5**. Countries are increasingly recognizing this role, including the importance of the LULUCF sector, as part of their mitigation – as well as adaptation – efforts, in their new or updated NDCs.

Countries were requested to communicate – by 2020 – a new NDC to the UNFCCC or update it depending on the time frame (Decision 1/CP 21, paragraphs 23 and 24).

Ninety percent of these "second generation" NDCs include the LULUCF sector within their scope, as compared to just 76 percent of the "first generation" NDCs submitted, with **57 percent of those NDCs referring to forests specifically**, as a domestic opportunity for reducing GHG emissions. The most prevalent policy options highlighted in NDCs were "afforestation, reforestation and revegetation" (52 percent) and "sustainable forest management" (31 percent). **Many countries refer to REDD+ explicitly in their NDCs**. Specific measures captured under REDD+ include, for example, the expansion of early warning systems for deforestation and the drafting and implementation of zero-deforestation agreements (UNFCCC, 2021).

Despite the enhanced role of the LULUCF sector in new and updated NDCs, **only about 20 percent of all NDCs include quantifiable targets for LULUCF**, such as hectares reforested, with less than half of those (about 8 percent of first generation NDCs) including GHG-based targets for the sector or metric tons of carbon dioxide equivalent.

There are a number of **REDD+ countries which have made important LULUCF enhancements in their new or updated NDCs** (e.g. reflecting the finalization and endorsement of REDD+ strategies that occurred after the first

NDC was in place and before submission of their new or updated NDCs).

Although Kenya's first NDC recognized the major contribution of forests to emissions and included the LULUCF sector in its scope, it made no specific reference to REDD+. Moreover, the NDC stated that the global land-use data approach used to develop the NDC led to significant uncertainty in the business as usual and mitigation potential estimates for the LULUCF sector. Harnessing the opportunity to draw on REDD+ progress made since that time, **the country's updated NDC refers explicitly to the enhancement of REDD+ activities and includes REDD+ in the set of sectoral policies** referred to as supporting implementation of its climate change adaptation and mitigation actions. On the data side, **the updated NDC was informed by a more detailed and robust assessment of mitigation and adaptation measures**, in-depth analysis, and improved information and data, including the most recently available national GHG inventory, supplemented by the best available data from various official sources and reports.

In the case of Cambodia, the potential for enhancement of the role of the LULUCF sector was explicitly recognized in the first NDC, with an explanation that while the LULUCF sector was included more generally in the initial NDC, a precise list of actions and GHG effects would be updated after finalization of the REDD+ strategy. Cambodia submitted its updated NDC in 2020, delivering on its stated intention to enhance the focus on REDD+. The country transitioned from sectoral targets to an economy-wide target, aimed at raising its mitigation ambition to a 42 percent reduction in 2030 compared with business as usual. This includes **a LULUCF sector target to decrease the deforestation rate by half by 2030**. Inclusion of this ambitious quantitative target addresses the largest source of emissions **in line with the national REDD+ strategy** and results in an updated NDC that is clearly more robust and comprehensive (UN-REDD, 2022).

While there are strong examples of enhancement of LULUCF via REDD+ in the NDCs, such as those above, many countries have **not yet fully explored the opportunities that REDD+ can bring to NDC development** to facilitate both mitigation and adaptation efforts in the forest sector.

REDD+ readiness efforts provide key entry points to integrate and/or enhance mitigation actions in the forest sector, into the NDCs, and to mobilize new and additional sources of finance for implementation.

NFMSs and related MRV activities are another key pillar of REDD+, which can **contribute significantly to the NDC enhancement process** and, in particular, to reporting on NDC progress as part of the BTRs to be submitted in 2024 and beyond in the context of the ETF, as discussed in Section 5.1.

The GHG-based estimates contained in the NDC for the forest sector may be improved given the ongoing reference level and MRV advancements that have been achieved through REDD+ readiness efforts. REDD+ countries have developed or substantially improved their own national data on GHG

emissions by sources and removals by sinks for the forest sector. In many developing countries, **national REDD+ data for the forest sector are more sophisticated and include more data points than the LULUCF sector GHG inventory** submitted as part of their national communications or BURs to UNFCCC. Therefore, NFMS and reference level development, carried out as part of REDD+ readiness efforts, has enabled many countries to include an unprecedented level of detail in their LULUCF emissions and removals profiles.

However, for many countries, forest sector data has not been fully integrated into the NDC process. The inclusion of a description of the assumptions and the methodological basis applied, specifically the reference levels, is particularly important for the land sector and could be enhanced by integrating REDD+ data. Even if not referenced directly in the NDC itself, it becomes particularly relevant to **ensure that the reporting on NDC progress in the BTRs builds on REDD+ data in those countries where such data is available**, so that this improved **data can be considered in the GST** (see Section 6.3). This is in alignment with the guidance provided as part of the UNFCCC Warsaw Framework for REDD+, which already requires such consistency between REDD+ and national GHG inventory reporting, though it is important to acknowledge the key differences between REDD+ submissions (e.g. reported by activity) and GHG inventories (e.g. reported by land-use categories) (see Section 5.1).

There is a significant opportunity to strengthen the robustness of BTRs and NDCs by mapping complementarities and potential inconsistencies between the national data used for BTRs and NDCs and the data used for REDD+ submissions. Most developing countries have based their NDC targets on projected emissions while REDD+ reference levels often use historical average emissions. REDD+ reference level submissions **go through TAs under the UNFCCC**, where countries receive input from LULUCF experts on areas for future technical improvements. This information can **contribute to enhanced transparency, completeness, consistency and accuracy of LULUCF sector information for the NDCs** (FAO, 2019).

6.3. THE GLOBAL STOCKTAKE AND THE MITIGATION POTENTIAL OF REDD+

As mentioned in Section 6.2, REDD+ reporting can provide key information on (part of) forests' contribution to climate change mitigation, which can be integrated in NDCs and BTRs, which are in turn key input documents for the GST. The GST aims to assess the world's collective progress towards achieving the long-term goals in the Paris Agreement. Forests play an important role in the global carbon cycle, absorbing approximately 11 billion tCO_2/yr as they grow, which is equivalent to 29 percent of annual anthropogenic CO_2

emissions (Friedlingstein *et al.*, 2022). Forests also emit an estimated 4 billion tCO_2/yr through deforestation and forest degradation, or 10 percent of the annual anthropogenic CO_2 emissions (Friedlingstein *et al.*, 2022), meaning that the net contribution of land (mainly forests) to the global carbon cycle is a net removal of about 7.6 tCO_2/year. The mitigation potential of forests is assessed by evaluating how much these fluxes can be influenced (i.e. how much the emissions from forests can be reduced and how much the removals can be increased).

The largest mitigation potential from forests in the short term is believed to be reducing emissions from deforestation and forest degradation (Roe *et al.*, 2017, 2021). Roe *et al.* (2021) estimated the cost-effective[22] **mitigation potential of reducing deforestation at 3.7 billion tCO_2eq/year** (entirely from developing countries), with a range of 1.6–5.6 billion tCO_2eq/year. Donegan and Sandker (2022), exploring global deforestation trends as reported by countries and by global Earth observation, find deforestation has been reduced globally and REDD+ has contributed to this reduction. As explained in Section 5.3, **the assessment of the mitigation potential of reducing deforestation strongly depends on the reference period** used for the reference level against which reductions are assessed. Similarly, Donegan and Sandker (2022), evaluating the reduction in deforestation with several global datasets, conclude that the assessment is strongly dependent on the reference period chosen: they find that comparing the most recent ten years of deforestation against the preceding ten years shows a strong decline, whereas a comparison of the most recent five years against the preceding five-year average reveals a more modest decline. They explain this with early performance in Latin America and the Caribbean. When performance becomes a new benchmark, outperforming past performance may be challenging. It remains to be seen whether and how market-based REDD+ reporting will impact UNFCCC REDD+ reporting. Another important aspect influencing the assessment of the mitigation potential of reducing deforestation is **the difference between reductions in gross and net forest area loss** (Gasser, Ciais and Lewis, 2022). Friedlingstein *et al.* (2022) assess gross CO_2 emissions from LULUCF to be 3.5 times higher than net CO_2 emissions from LULUCF.

The largest mitigation potential from forests on the longer term is believed to be from afforestation/reforestation (A/R) (Roe *et al.*, 2017), only part of which could be included in REDD+. Roe *et al.* (2021) estimated the cost-effective mitigation potential of A/R at 1.2 billion tCO_2eq/year globally. The cost-effective **mitigation potential of A/R in developing countries is estimated at 0.9 billion tCO_2eq/year** (Roe *et al.*, 2021). Different sources suggest strongly diverging estimates of A/R mitigation potential and suitable available land for A/R (Griscom *et al.*, 2017; IPCC, 2018; Bastin *et al.*, 2019; Lewis *et al.*, 2019). This may partially explain the large difference between

[22] Cost-effective is defined as with a cost < USD 100/tCO_2eq

the cost-effective mitigation potential of 1.2 billion tCO_2eq/year and the technical potential of 8.5 billion tCO_2eq/year (Roe *et al.*, 2021).

The **sink function of standing forests is very large, but poorly understood;** it remains **unknown how much it can be influenced by sustainable management of forest and forest conservation**. Section 5.1 discusses challenges in the assessment of removals from forest land remaining forest land. In addition to the technical challenges associated with assessing small carbon increases over vast forest areas, our understanding of how the sink function is influenced by various factors is also limited, making it difficult to assess whether a change in the sink is due to direct human-induced factors (e.g. forest management) or to indirect human-induced factors (i.e. the response of forest to environmental changes, such as CO_2 fertilization, nitrogen deposition and climate change). The majority of removals from growing forests tends to be associated with indirect human-induced factors and are expected to largely cancel out in REDD+ reporting when comparing removals over the results period with removals over the reference period, unless the forest grows more than expected during the results period. Such extra growth may be directly human-induced if it is a result of protective measures allowing forests to recover. Grassi *et al.* (2021, 2022) explain that differences in global forest sink estimates based on national estimates (used for the GST) and global models (used for IPCC pathways) are mostly caused by **different definitions of anthropogenic and non-anthropogenic sinks**, with national inventories generally considering most of the indirect effects as anthropogenic while global models consider them as natural. Grassi *et al.* (2022) further discuss differences between carbon fluxes assessed from different data reported by countries, stressing the importance of using the most up-to-date and comprehensive data with the right scope. Considering that most of the annual terrestrial sink (about 11 billion tCO_2, mostly assumed to occur in forests) (Friedlingstein *et al.*, 2022) is thought to be due to indirect human-induced effects, the estimated global cost-effective mitigation potential of forest management (i.e. linked to additional direct effects) is limited to 0.9 billion tCO_2/year. The cost-effective **mitigation potential of forest management in developing countries is 0.6 billion tCO_2/year** (Roe *et al.*, 2021). Several studies suggest the sink function of forests is reaching saturation (Nabuurs *et al.*, 2013; Zhu *et al.*, 2018; Hubau *et al.*, 2020; Gatti *et al.*, 2021). Despite its challenges, the sink function of forests should not be underestimated, and the risk exists that poor management, degradation and/or climate change could diminish or invert the sink function, resulting in the release of vast amounts of CO_2 in the future. The importance of conserving and enhancing the sink function is recognized in the Paris Agreement.

@FAO/Yelena Finegold

7. Concluding remarks

Important progress is being made on REDD+ under the UNFCCC, with a reported total of 11.5 billion tCO_2eq REDD+ ERs. As many as 56 developing countries submitted a REDD+ reference level to the UNFCCC. Of these, 18 countries (32 percent) submitted REDD+ results, which together add up to 11.5 billion tCO_2eq over the period 2006–2020. Of the total REDD+ ERs reported to the UNFCCC, 86 percent of all ERs reported are from Latin America (10 countries), 13 percent are from Asia and the Pacific (6 countries), and 1.7 percent are from Africa (2 countries) (see Section 5.2).

REDD+ RBP opportunities on the voluntary carbon market are increasing. The future of RBPs under the GCF is currently unclear. Meanwhile, the voluntary carbon market is seeing unprecedented growth and new jurisdictional REDD+ standards were launched in 2021 offering new REDD+ RBP opportunities to countries (see Section 2.1). Countries are beginning to report towards private-sector led voluntary carbon market standards.

REDD+ accounting has started for the FCPF CF with countries following a market-grade REDD+ standard. In 2020, Mozambique became the first country to report REDD+ results to the FCPF CF, followed shortly after by Ghana, Viet Nam, Costa Rica and Indonesia, together reporting 104 million tCO_2eq ERs for REDD+ results achieved between 2016 and 2021. In 2022, Guyana became the first country to report REDD+ results to ART-TREES for a total of 41.6 million tCO_2eq ERs achieved between 2016 and 2021. Of the combined total of 146 million tCO_2eq market-based REDD+ results reported, 60 percent is from Asia and the Pacific (two countries), 36 percent is from Latin America and the Caribbean (two countries), and 4 percent is from Africa (two countries) (see Section 5.2).

First jurisdictional REDD+ RBPs have been disbursed. The GCF RBP pilot programme disbursed a total of USD 497 million (for 97 million tCO_2eq ERs) to eight countries (seven of which are in Latin America and the Caribbean; one is in Asia and the Pacific) between 2020 and 2022, depleting the full envelope of the pilot programme. The first REDD+ RBP of USD 22.8 million (for a total of 4.6 million tCO_2eq ERs) under the FCPF CF was disbursed in 2021 and 2022, including the first REDD+ RBP to an African country. The RBPs made to date were all against a fixed price of USD 5/tCO_2eq; no payments for jurisdictional REDD+ have yet been made on the voluntary carbon market, where the market is expected to determine the price.

ER volumes reported to the UNFCCC and the voluntary carbon market are different by orders of magnitude. Reporting requirements in private-

sector led voluntary carbon market standards is more demanding than for the UNFCCC. Market-grade carbon standards prescribe – at a high level of detail – the approach to be taken for reference level setting; they include detailed requirements on allowable datasets and require a verification by an auditing firm. There is much more flexibility in reporting to the UNFCCC and countries asked to undertake stepwise improvements. Though ER reporting to the voluntary carbon market has only recently started and may still increase, its volume is expected to be limited, in part due to some of the following factors: the exclusion of early achieved ERs, the shortening of the reference period, and assessing ERs with sample-based approaches.

Countries are making important improvements, increasing the accuracy and transparency of REDD+ reporting. Sample-based methodologies are replacing pixel counts for assessments of deforestation and forest degradation AD, with 70 percent and 87 percent of UNFCCC and FCPF CF reference levels, respectively, including sample-based AD for deforestation (see Section 5.1). REDD+ results submitted to the UNFCCC are often reported against earlier reference level submissions and are for > 94 percent of the ER volume based on pixel-counting methodologies (see Section 5.3).

REDD+ reporting can be used to improve NDCs and BTRs. Some examples are provided where REDD+ countries have made important LULUCF improvements in their new or updated NDCs. Many countries are collecting new and improved data in the context of their REDD+ reporting; this information can contribute to the accuracy and enhanced transparency of LULUCF reporting and assessment of forest-based mitigation (see Section 6.2).

REDD+ reporting can contribute to the GST. Forests play a significant role in the global carbon cycle. REDD+ reporting can provide an important contribution to understanding the mitigation potential of forests in developing countries. It is important to neither overestimate nor underestimate the potential contribution from forests to climate change mitigation in order to keep a clear pathway towards reaching the goals in the Paris Agreement (see Section 6.3).

8. References

Architecture for REDD+ Transactions (ART). 2021. *The REDD+ Environmental Excellence Standard (TREES) Version 2*. Arlington, USA, ART Secretariat. www.artredd.org/wp-content/uploads/2021/12/TREES-2.0-August-2021-Executive-summary.pdf

ART. 2022. Listing of TREES Concept submissions. https://art.apx.com/myModule/rpt/myrpt.asp?r=111

Bastin, J.F., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C.M. & Crowther, T.W. 2019. The global tree restoration potential. *Science*, 365(6448): 76–79.

Donegan, E. & Sandker, M. 2022. Outcomes and Influences of REDD+ Implementation on Carbon. In: J. Parrotta, S. Mansourian, C. Wildburger & N. Grima, eds. *Forests, Climate, Biodiversity and People: Assessing a decade of REDD+ — IUFRO World Series Volume 40*, pp. 61—84. Vienna, IUFRO. www.iufro.org/fileadmin/material/publications/iufro-series/ws40/ws40.pdf

Emergent. 2021a. *LEAF Coalition Mobilizes $1 Billion for Tropical Forest Conservation*. www.emergentclimate.com/wp-content/uploads/2021/11/Press-Release-LEAF-Coalition-Mobilizes-1-Billion-for-Tropical-Forest-Conservation_021121-1.pdf

Food and Agriculture Organization of the United Nations (FAO). 2021. *Establishing legal frameworks for sustainable forest monitoring in REDD+ countries*. Rome, FAO. www.fao.org/documents/card/en/c/cb3525en

FAO. 2013. *National forest monitoring systems: monitoring and measurement, reporting and verification (M&MRV) in the context of REDD+ activities*. Rome, UN-REDD programme. www.fao.org/3/a-bc395e.pdf

FAO. 2015a. *Technical considerations for forest reference emission level and/or forest reference level construction for REDD+ under the UNFCCC*. Rome, UN-REDD programme. www.fao.org/3/a-i4847e.pdf

FAO. 2015b. *Emerging approaches to forest reference emission levels and forest reference levels for REDD+*. Rome, UN-REDD programme. www.fao.org/3/a-i4846e.pdf

FAO. 2017. *From reference levels to results reporting: REDD+ under the UNFCCC*. Forests and Climate Change Working Paper 15. Rome, FAO. www.fao.org/3/a-i7163e.pdf

FAO. 2018a. *From reference levels to results reporting : REDD+ under the UNFCCC. 2018 update*. Forests and Climate Change Working Paper 17. Rome, FAO. www.fao.org/3/CA0176EN/ca0176en.pdf

FAO. 2018b. *Strengthening national forest monitoring systems for REDD+*. National Forest Monitoring and Assessment Working Paper 47. Rome, FAO. www.fao.org/3/ca0525en/CA0525EN.pdf

FAO. 2019. *From reference levels to results reporting : REDD+ under the Framework Convention on Climate Change. 2019 update*. Forestry Working Paper 9. Rome, FAO. www.fao.org/3/ca6031en/ca6031en.pdf

FAO. 2020. *From reference levels to results reporting : REDD+ under the Framework Convention on Climate Change. 2020 update.* Forestry Working Paper 19. Rome. www.fao.org/3/cb1635en/cb1635en.pdf

FAO. 2020a. *Case study Bangladesh: An integrated national forest monitoring system for sustainable forest management and conservation in Bangladesh*. Rome, FAO. www.fao.org/3/cb1912en/cb1912en.pdf

FAO. 2020b. *Case study Costa Rica: Costa Rica's progress in developing a national land use, land cover and ecosystems monitoring system*. Rome, FAO. www.fao.org/3/cb5929en/cb5929en.pdf

FAO. 2020c. *Case study Democratic Republic of the Congo: The Democratic Republic of the Congo establishes a national forest monitoring system to promote sustainable forest management*. Rome, FAO. www.fao.org/3/cb0702en/CB0702EN.pdf

FAO. 2021a. *Institutionalisation of forest data: Establishing legal frameworks for sustainable forest monitoring in REDD+ countries*. Rome, FAO. https://doi.org/10.4060/cb3525en

FAO. 2021b. *Case Study Chile: The National Forest Monitoring System as part of the National Strategy on Climate Change and Vegetation Resources in Chile*. Rome, FAO. www.fao.org/3/cb4253en/cb4253en.pdf

FAO. 2021c. *Case study Ghana: Establishing a multi-purpose national forest monitoring system to improve land use monitoring capacities in Ghana*. Rome, FAO. www.fao.org/3/cb4778en/cb4778en.pdf

FAO. 2021d. *Case study Papua New Guinea: National forest monitoring system provides better data, and enhances capacity in Papua New Guinea*. Rome, FAO. www.fao.org/3/cb4911en/cb4911en.pdf

FAO. 2022. *Towards open and transparent forest data for climate action: Experiences and lessons learned*. Rome, FAO. www.fao.org/documents/card/en/c/cb8908en

Forest Carbon Partnership Facility (FCPF). 2016. *Carbon Fund Methodological Framework*. Washington, DC, USA, FCPF. www.forestcarbonpartnership.org/system/files/documents/fcpf_carbon_fund_methodological_framework_revised_2016.pdf

FCPF. 2020. *Carbon Fund Methodological Framework*. Washington, DC, USA, FCPF. www.forestcarbonpartnership.org/system/files/documents/fcpf_carbon_fund_methodological_framework_revised_2020_final_posted.pdf

FCPF. 2021a. *Process Guidelines Version 5.2*. Washington, DC, USA, FCPF. www.forestcarbonpartnership.org/system/files/documents/fcpf_process_guidelines_2021_v5.2.pdf

FCPF. 2021b. *Guidance Note on accounting of legacy emissions/removals*. Washington, DC, USA, FCPF. www.forestcarbonpartnership.org/sites/fcp/files/FCPF%20Guidance%20Note%20on%20Accounting%20of%20Legacy%20Emissions%20and%20Removals_2021_0.pdf

FCPF. 2022a. Carbon Fund Dashboard. Washington, DC, USA, FCPF. www.forestcarbonpartnership.org/carbon-fund-dashboard

FCPF. 2022b. Carbon Fund Post ERPA – Signing Dahsboard. Washington, DC, USA, FCPF. www.forestcarbonpartnership.org/post-erpa-signing-milestones

Forest Trends' Ecosystem Marketplace. 2021. State of Forest Carbon Finance 2021. Washington DC, Forest Trends Association. www.ecosystemmarketplace.com/publications/state-of-forest-carbon-finance-2021

Forest Trends' Ecosystem Marketplace. 2022. The Art of Integrity. State of Forest Carbon Markets: Q3 insight briefing. Washington, DC, USA, Forest Trends Association. www.ecosystemmarketplace.com/publications/state-of-the-voluntary-carbon-markets-2022

Friedlingstein, P., Jones M.W., O'Sullivan, M., Andrew, R.M., Bakker, D.C., Hauck, J., Le Quéré, C. *et al.* 2022. Global carbon budget 2021. *Earth System Science Data* 14(4): 1917-2005.

Gasser, T., Ciais, P. & Lewis, S.L. 2022. How the Glasgow Declaration on Forests can help keep alive the 1.5°C target. Proceedings of the National Academy of Sciences of the United States of America (PNAS) DOI: 10.1073/pnas.2200519119

Gatti, L.V., Basso, L.S., Miller, J.B., Gloor, M., Gatti Domingues, L., Cassol, H.L., Tejada, G., Aragão, L.E., Nobre, C., Peters, W. and Marani, L. 2021. Amazonia as a carbon source linked to deforestation and climate change. *Nature*, *595*(7867), pp.388-393.

Global Forest Observations Initiative (GFOI). 2016. *Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests: methods and guidance from the Global Forest Observations Initiative*. Edition 3.0. Global Forest Observations Initiative. Rome, FAO. www.reddcompass.org/documents/184/0/MGD2.0English/c2061b53-79c0-4606-859f-ccf6c8cc6a83

GFOI. 2018. *Summary of country experiences and critical issues related to estimation of activity data*. White paper (module)., A. Espejo, C. Green, M. Herold, M.-J. Sanz-Sanchez, I. Jonckheere, E. Lindquist, R. McRoberts, E. Næsset, P. Olofsson & C. Sannier, eds. 34 pp. Global Forest Observations Initiative. Rome, FAO.

Green Climate Fund (GCF). 2017. *Terms of reference for the pilot programme for REDD+ results-based payments*. Incheon, Republic of Korea, GCF. www.greenclimate.fund/sites/default/files/document/terms-reference-pilot-programme-redd-results-based-payments.pdf

GCF. 2019. *Concept Note REDD+ results based payments: Papua New Guinea REDD+ RBP for results period 2014-2015*. Incheon, Republic of Korea, Green Climate Fund. www.greenclimate.fund/sites/default/files/document/23260-papua-new-guinea-redd-rbp-results-period-2014-2015.pdf

GCF. 2020a. Analysis of the experience with and the progress made towards achieving the objectives of the pilot+ programme for REDD-plus results-

based payments: a midterm review. GCF/B.25/Inf.06/Add.01. Incheon, Republic of Korea, Green Climate Fund. www.greenclimate.fund/document/gcf-b25-inf06-add01

GCF. 2020b. *Concept Note REDD+ results based payments: Vietnam REDD-plus results-based payments for results period of 2014.* www.greenclimate.fund/sites/default/files/document/25080-vietnam-redd-plus-results-based-payments-results-period-2014.pdf

Grafström, A., Zhao, X., Nylander, M. & Petersson, H. 2017. A new sampling strategy for forest inventories applied to the temporary clusters of the Swedish NFI. *Canadian Journal of Forest Research*, 47: 1161–1167. https://doi.org/10.1139/cjfr-2017-0095

Grassi, G., Stehfest, E., Rogelj, J., van Vuuren, D., Cescatti, A., House, J., Nabuurs, G.-J. *et al.* (2021) Critical adjustment of land mitigation pathways for assessing countries' climate progress, *Nature Climate Change*, 11, 425–434, https://doi.org/10.1038/s41558-021-01033-6

Grassi, G., Conchedda, G., Federici, S., Abad Viñas, R., Korosuo, A., Melo, J., Rossi, S., Sandker, M., Somogyi, Z. & Tubiello, F.N. (forthcoming). Carbon fluxes from land 2000–2020: bringing clarity on countries' reporting, *Earth Syst. Sci. Data Discuss*. https://doi.org/10.5194/essd-2022-104

Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., Miteva, D.A., Schlesinger, W.H., Shoch, D., Siikamäki, J.V., Smith, P. & Woodbury, P. 2017. Natural climate solutions. *Proceedings of the National Academy of Sciences*, 114(44): 11645-11650.

Hubau, W., Lewis, S.L., Phillips, O.L., Affum-Baffoe, K., Beeckman, H., Cuní-Sanchez, A., Daniels, A.K., Ewango, C.E., Fauset, S., Mukinzi, J.M. & Sheil, D. 2020. Asynchronous carbon sink saturation in African and Amazonian tropical forests. *Nature*, 579(7797): 80-87.

International Civil Aviation Organization (ICAO). 2022. *CORSIA Eligible Emissions Units. International Civil Aviation Organization*. www.icao.int/environmental-protection/CORSIA/Documents/TAB/ICAO%20Document%2008_CORSIA%20Eligible%20Emisions%20Units_March%202022.pdf

Intergovernmental Panel on Climate Change (IPCC). 2006. *2006 IPCC guidelines for national greenhouse gas inventories*. Prepared by the National Greenhouse Gas Inventories Programme. H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe, eds. Vol. 4, Chap. 3.2. Intergovernmental Panel on Climate Change. Kanagawa, Japan, Institute for Global Environmental Strategies.

IPCC. 2018. *Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield, eds.

IPCC. 2019. *2019 refinement to the 2006 IPCC guidelines for national greenhouse gas inventories*, Vol. 4: *Agriculture, forestry and other land use*, Chap. 10: Emissions from livestock and manure management. E. Calvo Buendia, K. Tanabe, A. Kranjc, J. Baasansuren, M. Fukuda, S. Ngarize, A. Osako, Y. Pyrozhenko, P. Shermanau & S. Federici, eds. Geneva, Switzerland, Intergovernmental Panel on Climate Change.

Joint Crediting Mechanism (JCM). 2022. About the mechanism. www.jcm.go.jp/la-jp/about

Köhl, M., Scott, C.T., Lister, A.J., Demon, I. & Plugge, D. 2015. Avoiding treatment bias of REDD+ monitoring by sampling with partial replacement. *Carbon Balance and Management,* 10: 11. https://doi.org/10.1186/s13021-015-0020-y

Lee, D., Skutsch, M. & Sandker, M. 2018. *Challenges with measurement and accounting of the plus in REDD+*. San Francisco, USA, Climate and Land Use Alliance. www.climateandlandusealliance.org/reports/plus-in-redd

Lewis, S. L., Wheeler, C. E., Mitchard, E.T.A., & Koch, A. 2019. Regenerate natural forests to store carbon. *Nature*, 568, 25–28.

Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition. 2022. https://leafcoalition.org

Nabuurs, Gert-Jan, Lindner, M., Verkerk, P.J., Gunia, K., Deda, P., Michalak, R. & Grassi, G. 2013. "First signs of carbon sink saturation in European forest biomass." *Nature Climate Change* 3(9): 792–796.

Nesha, M.K., Herold, M., De Sy, V., Duchelle, A.E., Martius, C., Branthomme, A., Garzuglia, M., Jonsson, O. & Pekkarinen, A. 2021. An assessment of data sources, data quality and changes in national forest monitoring capacities in the Global Forest Resources Assessment 2005–2020. *Environmental Research Letters*, *16*(5), 054029.

Norway's International Climate and Forest Initiative (NICFI). 2022. Partner countries. www.nicfi.no/partner-countries

Olofsson, P., Foody, G.M., Herold, M., Stehman, S.V., Woodcock, C.E. & Wulder, M.A. 2014. Good practices for estimating area and assessing accuracy of land change. *Remote Sensing of Environment*, 148: 42–57. https://doi.org/10.1016/j.rse.2014.02.015

Räty, M. & Kangas, A. 2019. Effect of permanent plots on the relative efficiency of spatially balanced sampling in a national forest inventory. *Annals of Forest Science*, 76. https://link.springer.com/article/10.1007/s13595-019-0802-6

REDD Early Movers (REM) programme. 2022. www.kfw-entwicklungsbank.de/International-financing/KfW-Development-Bank/Topics/Climate/REDD/

Roe, S., Streck, C., Weiner, P.H., Obersteiner, M. & Frank, S. 2017. How Improved Land Use Can Contribute to the 1.5°C Goal of the Paris Agreement. Working Paper prepared by Climate Focus and the International Institute for Applied Systems Analysis.

Roe S., Streck C., Beach R., Busch J., Chapman, M., Daioglou V., Deppermann A., Doelman J., Emmet-Booth J., Engelmann J. *et al.* (2021). Land-based measures to mitigate climate change: Potential and feasibility by country. *Global Change Biology*, 27, 23, 6025–6058.

Sandker, M., Carrillo, O., Leng, C., Lee, D., d'Annunzio, R. & Fox, J. 2021. The Importance of High–Quality Data for REDD+ Monitoring and Reporting. *Forests*, 12 (1): 99. https://doi.org/10.3390/f12010099mdpi.com/1999-4907/12/1/99

The Science Based Targets initiative (SBTi). 2022. https://sciencebasedtargets.org/

United Nations Framework Convention on Climate Change (UNFCCC). 2021. *Nationally determined contributions under the Paris Agreement: Revised synthesis report by the secretariat.* Bonn, Germany, UNFCCC. https://unfccc.int/documents/307628

UNFCCC. 2022. *Reference Manual for the Enhanced Transparency Framework under the Paris Agreement Understanding the enhanced transparency framework and its linkages*. Bonn, Germany, UNFCCC. https://unfccc.int/sites/default/files/resource/v2_ETFreferencemanual.pdf

UN-REDD. 2022. Linking REDD+, the Paris Agreement, nationally determined contributions and the Sustainable Development Goals: Realizing the potential of forests for NDC enhancement and implementation. Geneva. un-redd.org/sites/default/files/2022-03/NDC%20Final.pdf

Verra. 2021a. The Voluntary Carbon Standard for Jurisdictional and Nested REDD+ (VCS-JNR). https://verra.org/project/jurisdictional-and-nested-redd-framework/rules-requirements/jnr-version-4

Verra. 2021b. JNR Registration and Issuance Process. https://verra.org/wp-content/uploads/2021/04/JNR_Registration_and_Issuance_Process_v4.0.pdf

Yanai, R.D., Wayson, C., Lee, D., Espejo, A.B., Campbell, J.L., Green, M.B., Zukswert, J.M., Yoffe, S.B., Aukema, J.E., Lister, A.J. *et al.* 2020. Improving Uncertainty in Forest Carbon Accounting for REDD+ Mitigation Efforts. *Environmental Research Letters*, 15(12): 124002. https://doi.org/10.1088/1748-9326/abb96f

Zhu, K., Zhang, J., Niu, S., Chu, C. & Luo, Y. 2018. Limits to growth of forest biomass carbon sink under climate change. *Nature communications*, 9(1): 1-8.

For more information, please contact:

Forestry Division - Natural Resources and Sustainable Production
E-mail: NFO-Publications@fao.org
Web address: www.fao.org/forestry/en

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